SCHLICH'S

MANUAL OF FORESTRY.

VOLUME I.

FOREST POLICY

IN THE

BRITISH EMPIRE.

BY

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LATE INSPECTOR-GENERAL OF FORESTS TO THE GOVERNMENT OF INDIA.

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PREFACE

In the preface of the first edition of this volume it was explained that this Manual of Forestry was destined, in the first place, for the instruction of probationers for the Indian Forest Service. It was also stated that, during the progress of the work, alterations of the original plan were likely to be introduced. The third edition of Volumes I. and II. has accordingly been re-arranged. The second half of Volume I. has been transferred to Volume II., and instead I have considerably enlarged that part of Volume I. which deals with "Forestry in Britain and in India," so that it has become an abstract of "Forestry in the British Empire." The account is far from perfect, since it was not an easy task to obtain reliable information regarding various parts of the Empire. I shall, however, set to work at once to perfect it, in case I should live to see a further edition.

The Manual is now divided into the following volumes:

Volume I.—Forest Policy in the British Empire.
" II.—Sylviculture.
" III.—Forest Management.
" IV.—Forest Protection.
" V.—Forest Utilization.

As is well known, Volumes I, II. and III. are written by me, and Volumes IV. and V. are by my colleague, Mr. W. R. Fisher.

Each volume can be purchased separately, and the prices have been kept as low as possible.

The original object of the work has been steadily kept in view. It is to give a clear picture of Forestry as practised in those countries where that industry has been brought to

greatest perfection, so that the students who go out to India or to the Colonies, or even those who remain in this country, should become acquainted with the best methods of managing forests. When they have once mastered those methods, they will be able to apply them, within a short space of time. to the special conditions in which they have to work. This object has, during the last few years, here and there been overlooked or disregarded. Attempts have been made to teach *British* as opposed to *Continental* forestry. Before this can successfully be done, we must set to work and collect statistics derived from home experience. When we have accomplished this, we can proceed and write economic British forestry. Until then, it would be unwise to reject the experience gained elsewhere, even if it is derived from foreign sources. The great amount of work devolving upon me will not permit my taking as active a part in the collection of statistics as I should like to do, but I shall ever be ready to give advice to those who take up the work, if they wish to have it. I cannot close these remarks without mentioning one instance to the point. Mr. A. C. Forbes, the lecturer on forestry at the Armstrong College, in the University of Durham, has commenced collecting data in British woods on lines which are likely to produce useful results, and I trust that others will soon follow his example.

I desire to offer my thanks to my old friend, Mr. F. B. Manson, late Conservator of Forests in India, for looking over the proofs of this volume.

W. SCHLICH.

OXFORD,
28th February, 1906.

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A MANUAL OF FORESTRY.

INTRODUCTION.

The greater part of the dry land of the earth was, at one time or another, covered with forest, which consisted of a variety of trees and shrubs grouped according to the climate, soil and configuration of the several countries. When the old trees reached their limit of life they disappeared, and others took their place. The conditions for an uninterrupted regeneration of the forests were favourable, and the result was vigorous production by the creative power of the soil and climate. Then came man and interfered, not at once but by slow degrees, until in the more civilised countries of the earth the area under forest was considerably reduced. But more than this: the creative power of the soil in the remaining forest lands had, through injudicious and careless treatment, become more or less impaired. Steps had then to be taken to arrest a further reduction of the forest area; in many cases the forest had to be re-planted and the original creative power re-established; thus a task presented itself which forestry had to undertake. What is now understood by that term did not spring into existence all at once but was built up gradually, as necessity in various directions arose.

As long as forests occupied considerable areas, their produce was considered the free gift of nature, like air and water; man took it, used it and even destroyed it without let or hindrance. Hence *Forest Utilization* is the oldest branch of forestry.

With the gradual increase of population, more land was required for the production of field crops and the feeding of

cattle, and this was taken from the forest area; reckless cutting and burning consumed more forest, until a time came when it appeared doubtful whether the natural woodlands could continue to yield the required produce for any length of time, if treated in the manner so far customary. This caused proprietary ideas to be developed; people claimed the ownership of certain forest lands, proceeded to protect them against outsiders, and thus the first signs appeared of that branch of forestry which is called "*Forest Protection*." The protection, originally designed against man only, extended gradually to measures which had for their object the preservation of forests from injurious attacks by animals, especially insects, noxious plants, in particular fungi, natural phenomena and other injurious agencies.

By degrees, it was found that mere protection was not sufficient, that steps must be taken to enforce a more judicious treatment and to limit the extraction of produce to what the forest was capable of producing; in other words, to determine the annual or periodical production, and to regulate the yield accordingly. Thus that branch which deals with the "*Preparation of Forest Working Plans*" sprang into existence.

Something more was, however, required. With increasing demand it became evident that the ordinary natural regeneration could not keep pace with the rate at which the mature trees were removed. It became necessary to assist regeneration by artificial means, either by arranging the cuttings so as to favour and assist natural regeneration, or by artificial sowing and planting. Moreover, the young trees required special tending in order to produce the most useful description of produce. In this way, a fourth branch of forestry was developed which is called "*Sylviculture*."

As time went by, forests rose in value; they became articles of exchange or sale, and it was found necessary to devise a system for readily ascertaining their value. This produced another branch which is called "*Forest Valuation*" or "*Forest Finance*."

Originally, the protection which the owner of a forest could give to it was sufficient to guard it against mischief and interference. Subsequently, this proved no longer sufficient, and the owner appealed to the State for help. It was also found that certain forest lands were of special importance to the community as a whole, either on account of their produce, or for climatic reasons, or on account of the protection which they yielded to adjoining lands. To regulate these matters, the State had to pass certain laws which are known as *Forest Laws and Forest Regulations*.

With the development of Political Economy, the forest question naturally was drawn within its province. It was asked, whether and in how far forests need be maintained in a country, whether the State as such should hold the forest lands, or whether the maintenance of forests might be left to private enterprise, and thus a further branch called *Forest Policy* was created.

The task, then, with which forestry has to deal is one of considerable extent; it may shortly be defined as follows:—

To ascertain the principles according to which forests shall be managed (Forest Science), and to apply these principles to the treatment of forests (Practical Forestry).

The measures at first adopted in forestry have, with the advance of other branches of learning, been considerably elaborated. By degrees, the teachings of general science have been brought to bear upon the subject, so that at the present day a fully competent forest expert must be acquainted with many branches of what may be called, from this point of view, sciences auxiliary to forestry. Amongst these may be mentioned:—

Pure and Applied Mathematics.
Surveying.
Elements of General Law.
Political Economy.
Physics, including Meteorology.

Chemistry, Inorganic and Organic, including a knowledge of Soils.
Mineralogy and Geology.
Zoology, especially Entomology.
Botany.

The study of natural history should be conducted with special reference to forestry, but for economic forestry a knowledge of mathematics is equally important.

The present object is to place before the reader an account of the more important branches of forestry itself. In doing this, it is assumed that the student has acquired a sufficient knowledge of the sciences auxiliary to forestry. Before proceeding with that task, it is necessary to explain a few terms which are used in the following pages.

The term "*Forest*" has been used above. Although most people know what a forest is, a definition of it which suits all cases is by no means easy to give. In England, a forest was formerly understood to mean an area which was stocked with deer; such an area was more or less covered with trees and shrubs, but not necessarily so. Thus *Manwood*, in his treatise of the "Lawes of the Forest, 1598," defines a forest as follows:—

"A forest is a certain territory of woody grounds, fruitful pastures, privileged for wild beasts and fowls of forest, chase, and warren, to nest and abide in, in the safe protection of the King, for his princely delight and pleasure, which territory of ground, so privileged, is meered and bounded with unremovable marks, meers and boundaries, either known by matter of record, or else by prescription," etc.

This definition has in modern times, when the economic aspect of forests came more into the foreground, given way to others. Thus *Hundeshagen*, in the early part of the nineteenth century, understood by forest an area which contains wild growing trees. This definition is not in all cases correct, because many forests,* which now exist, were artificially

* Even the greater part of *Epping* forest seems to have been artificially created, especially the parts where hornbeam prevails

created, and sowing and planting may be going on in them at the present time.

Cotta, about the same time, defined a forest as an area which has been set aside principally for the production of wood, and which, for the greater part at any rate, is covered with trees. It may be objected that many areas are classed as forest which do not contain trees, while others, like avenues and hedgerows, bear trees and produce wood, although they cannot be called forests.

These illustrations will suffice to show how difficult it is to draw up a general definition which suits all cases. The Indian Legislature, when preparing a forest law for India, decided, therefore, not to attempt a definition, but merely to provide that the Government may declare certain lands to be forests and thus bring them under the operation of the Indian Forest Law.

In a general way, forest may be described as an area which for the most part is set aside for the production of timber and other forest produce, or which is expected to exercise certain climatic effects, or to protect the locality against injurious influences; such areas are frequently subject to special forest laws and regulations.

Matters become easier when turning to the term *Wood*.— By a wood, or woodland, (plantation), is understood an area of defined dimensions, which is stocked with trees or shrubs or both, and managed for the production of timber, firewood, and such other produce as ordinarily accompanies the rearing of trees. Every wood is, therefore, a forest, but not every forest is a wood.

The difference between a tree and a shrub is not always easy to define. For sylvicultural requirements, the following definitions will suffice:—

Tree means a woody plant which, from natural tendency, divides into two or more main branches, either at some distance from the ground, or not at all.

Shrub means a woody plant which, from natural tendency,

divides into two or more main branches at or near the ground.

A tree consists of three parts, the stool, the bole and the crown :—

Stool means that part which remains in the ground after a tree has been felled close to the ground; it comprises the whole of the root system and the lower end of the stem up to the point where it emerges from the ground, or a short distance above the surface.

Bole means the stem, or trunk, of the tree from the ground to the point where it divides into a number of main branches. The lower part of the bole, which is free of any branches, is called the *clear bole.* In many cases, bole and clear bole are identical.

Crown means the whole system of branches and that part of the main stem which is above the clear bole. In some cases, where side branches have been developed below the upper end of the bole, the crown and bole overlap each other.

A tree or shrub may start as a seedling, stoolshoot, sucker, or layer :—

Seedling means a tree or shrub which has sprung up from seed.

Stoolshoot means a shoot which has sprung up from the stool of a tree or shrub previously cut down.

Sucker, or *rootsucker*, means a shoot which has sprung up from a root.

Layer means a branch which has been bent down, partly buried in the soil, and which has developed roots of its own; it may subsequently be severed from the mother plant and develop into an independent tree or shrub.

With regard to the age of trees and woods, the following stages may be distinguished, when the trees have emerged from that of seedlings.

Thicket means a dense crop of young trees from the time when the branches commence interlacing until the time when

the lower ones begin to die and fall; a thicket is composed of *saplings*.

Pole forest means a crop of trees from the time when the lower branches commence falling (the bole thus clearing itself), until towards the end of the principal height growth; it consists of *poles*.

Tree forest means a crop of trees which is passed the period of principal height growth; it consists of *trees*, or *formed trees*. Towards the end of this stage it is called a *mature forest or wood*.

A further distinction must be made, in respect of the persistency of the leaves, between evergreen and deciduous trees:—

Evergreen tree means a tree the leaves of which persist for not less than one year, so that it is at no season without leaves.

Deciduous tree means a tree which is leafless for some time during each year.

Woods may be classified as follows:—

Pure wood (or forest) means a wood which consists of one species only.

Mixed wood (or forest) means a wood which consists of two or more species intermixed; the mixture can be arranged according to single trees, alternate lines, or groups.

Again:—

Crowded wood, or dense wood, means a wood which is completely stocked, so that the crowns of the trees interlace and form an uninterrupted leaf canopy which thoroughly shelters the ground.

Thin wood, or open wood, means a wood in which the crowns of the trees do not interlace, but form an interrupted leafy canopy which only partially shelters the ground. A thin wood may be regularly or irregularly stocked.

For the sake of convenience, the produce which forests yield is divided into principal or major, and minor produce:—

Principal or major produce means timber and firewood.

Minor produce means all forest produce except timber and firewood.

Increment means the material produced on a tree, or a given area, in a certain time; *annual increment* means the material produced in one year.

Growing stock means the material actually standing on a given area at a certain time; it consists of an accumulation of annual increments from the creation of the wood up to a given time less the quantity which has been taken out.

Rotation means the time which elapses between the formation of a crop of trees and its final removal.

Final yield means the material obtained by the removal of the final crop, whether the removal is effected by one or by several successive cuttings.

Intermediate yield means the material obtained by intermediate cuttings, or cleanings, thinnings and pruning.

The three principal sylvicultural systems, or methods of treatment, are represented by high forest, coppice forest and coppice with standards:—

Seedling or high forest.—The trees have sprung up from seed; they are permitted to grow up until they have reached the desired size, when they are cut over, and a new crop is started again consisting of seedlings; ordinarily, the final cutting does not take place until after the end of the pole stage.

Coppice forest, or copse.—The trees consist of stool shoots or root suckers which are cut over periodically, either close to the ground or at some distance from it, every succeeding crop being produced in the same way.

Coppice with standards, or stored coppice.—A combination of the above two systems: the forest consists of an overwood and an underwood; the latter is a coppice which is periodically cut over, the stools providing each time a fresh crop; the overwood consists of seedling trees, and occasionally of vigorous stool shoots, which are allowed to reach at least twice the age of the underwood, and are called the standards or stores.

Quality of locality means the yield capacity of a piece of land according to the nature of the soil and the climate of the locality.

These definitions will suffice for the present; all further terms will be explained as may be necessary.

The matters dealt with in this volume have been arranged under the following headings:—

PART I.—THE UTILITY OF FORESTS.

PART II.—THE STATE IN RELATION TO FORESTRY.

PART III.—FORESTRY IN THE BRITISH EMPIRE.

PART I.

THE UTILITY OF FORESTS.

THE UTILITY OF FORESTS.

Forests are, in the economy of man and of nature, of direct and indirect value; the former chiefly through their produce and the latter through the influence which they exercise upon climate, the regulation of moisture, the stability of the soil, the healthiness of a country and allied subjects. The effects of forests may be looked at from the point of view of the owner, or from that of the State. The owner considers, in the first place, the benefits which he personally derives from his forests; the State appreciates the effects which they have upon the country and the nation as a whole; hence, in the majority of cases, the owner is concerned chiefly with the direct effects, and the State with the indirect effects, or with both.

Each class of effects must be considered separately.

CHAPTER I.

DIRECT UTILITY OF FORESTS.

The important direct effects of forests are due to the produce which they yield, the capital which they represent and the work which they provide.

1. *The Produce of Forests.*

a. Principal Produce or Wood.

Wood is used as *timber* in construction, shipbuilding, machinery, industries, agriculture, for tools, furniture, etc., and as *fuel* for domestic and industrial firing. The quantity of wood required in a country depends on various considerations which will be dealt with further on. In modern times, iron and other materials have to a considerable extent replaced timber, while coal, lignite and peat compete with firewood; nevertheless, wood is still indispensable and likely to remain so. The more general introduction of substitutes for firewood has, however, drawn increased attention to the production of timber in preference to firewood. For instance, of the total produce of the Saxon State forests only 35 per cent. was classified as timber in 1850, but the proportion had risen to 82 per cent. in 1900. Similarly, in Bavaria it rose from 16 per cent. in 1850 to 50 per cent. in 1900.* At the same time, new industries which consume wood have sprung up, such as the preparation of wood pulp for the manufacture of paper. It is estimated that the manufacture of the wood pulp imported into the United Kingdom consumes about 50,000,000 cubic feet of timber annually, the value of the imported pulp

* R. Weber in Lorey's "Handbuch der Forstwissenschaft, 1903."

being £2,250,000 on an average. Aspen and fir firewood are now cut up for matches; beech, formerly the staple firewood, is used for furniture, floors, packing cases, pavements, wooden shoes, etc.

A part of the firewood is converted into charcoal or ashes. Considerable quantities of the former are still used in domestic firing, iron smelting where a raw material of special excellence is required, in the manufacture of gunpowder and for a variety of other purposes. Ashes are used for the manufacture of potash, or as manure.

The quantity of wood consumed in various countries differs very much. Taking timber alone, the consumption is as follows:—

In France	= 7	cubic feet	per head	of population.
„ Belgium	= 12	„	„	„
„ the United Kingdom	= 14	„	„	„
„ Germany	= 18	„	„	„
„ Canada	= 60	„	„	„

The imports of timber into the United Kingdom amount to about ten million tons a year, and the home production may be estimated at two million tons.

b. Minor Forest Produce.

As all produce which is not timber or firewood is included under minor forest produce, it will easily be understood that the term comprises a great variety of articles, amongst which may be mentioned: bark especially for tanning, turpentine, resin, caoutchouc, gutta-percha, catechu and numerous other dye-stuffs, leaves, flowers, fruits, seeds, fibres, grass, moss, peat, bamboos, canes, lac, honey, wax, and many others. Several of these materials, such as grass, leaves and moss, play an important part in small farming, especially in poor countries, while others furnish the raw material for extensive industries. In order to illustrate the latter point it may be mentioned that Great Britain and Ireland import such articles

of an estimated value of close on £12,000,000 a year, as the following statement shows:—

AVERAGE ANNUAL IMPORTS OF MINOR FOREST PRODUCE INTO THE UNITED KINGDOM.

Caoutchouc	value	£6,027,050
Gutta-percha	„	1,180,296
Dye-stuffs	„	518,014
Dye-wood	„	249,412
Myrabolans	„	170,876
Gums of various kinds	„	1,305,683
Oil of turpentine	„	884,574
Rosin	„	528,728
Galls	„	76,807
Pitch	„	42,966
Tar	„	92,706
Vegetable fibres	„	779,190
Total value		£11,806,302

2. *Forests as Objects of Industry.*

Forests occupy a certain portion of the earth's surface; hence forestry forms part of agriculture in its widest sense. They are important objects of industry, representing a large amount of capital, and they require labour in various ways though at a rate different from that of other branches of agriculture.

a. The Capital of Forestry.

The capital employed in forestry consists principally of the soil and the growing stock of wood, the latter being an accumulation of a number of years' increment. When the working is of an intermittent nature, the amount of capital fluctuates from time to time; when the working is so arranged that an equal annual return is secured, the capital remains of the same amount and consists of the soil plus the growing

stock which is present at the commencement of the annual growing season.

The soil is called the fixed and the growing stock the movable or shifting capital of forestry. The proportion of the one to the other depends chiefly on the species, the method of treatment and the length of the rotation. In forests treated as coppice woods, the fixed may be greater than the movable capital, but in high forests, where the object is to produce timber of some size, the shifting capital is generally of considerably greater value than the soil. An example will illustrate this:—Assuming that an area of 100 acres is treated as a Scotch pine timber forest under a rotation of 100 years, with the object of obtaining an annually equal return; in that case, one acre must be stocked with 1-year-old seedlings, another with 2-year-old seedlings, another with 3-year-old young trees and so on to the last acre which would be stocked with trees 100 years old. Every year the oldest wood, 100 years old, is cut over and the area at once re-stocked. Immediately after the cutting, 99 acres remain stocked with trees ranging in age from 1 year to 99 years, and this is called the *normal growing stock*. Without the presence in the forest of this series of age gradations it would be impossible to obtain a regular annual yield of trees 100 years old.

The subjoined table gives the capital invested in a forest worked on the principle of a sustained annual yield. The data for the growing stock are taken from the Yield Tables for the Scotch pine, to be found at pages 362—367 of Volume III. of this Manual (third edition, 1905). In calculating the value of the growing stock it has been assumed that fagots and root wood do not yield any net money return, and that the timber, including all pieces of 3 inches diameter and upwards at the thin end, would realise 2 pence per cubic foot under a rotation of 30 years, gradually rising to 10 pence per cubic foot under a rotation of 120 years. Soil adapted for the growth of Scotch pine is generally light, and the value of such land of the I. or best quality cannot, on an

average, be estimated at more than £25 per acre, while land of the II. or middling quality may be estimated at £12 an acre, and land of the III. or lowest quality at £4, though land of the latter quality is frequently worth considerably less.

Length of Rotation, in Years	Capital Invested in Foresiry—Pounds Sterling per Acre, Average								
	I Quality, best			II Quality, middling			III Quality, lowest		
	Soil	Growing Stock	Total	Soil	Growing Stock	Total	Soil	Growing Stock	Total
30	25	6	31	12	2 5	14 5	4	25	4 25
40	25	13	38	12	6	18	4	2·	6
50	25	23	48	12	12	24	4	3·	7
60	25	38	63	12	22	34	4	7	11
70	25	58	83	12	35	47	4	12	16
80	25	81	106	12	49	61	4	19	23
90	25	107	132	12	66	78	4	26	30
100	25	135	160	12	84	96	4	34	38
110	25	165	190	12	104	116	4	43	47
120	25	197	222	12	124	136	4	53	57

This table shows:—

(1.) That the capital increases with the length of the rotation.

(2.) That the value of the growing stock is at first smaller than the value of the soil, equal to it under a rotation of from 50 to 60 years and greater after that period. Under a rotation of 100 years, for instance, the proportion is as follows:—

	Growing Stock		Soil.
For the I. quality	5·4	:	1.
,, II. ,,	7·	:	1.
,, III. ,,	8·5	:	1.

(3.) That the capital invested in timber forests is considerably greater than that of the soil only. Hence, if forests give a higher return than fields, it does not follow that the investment in the former is of a more

profitable nature, as such higher returns represent the income of a much larger capital. It will be shown in Volume III. under what conditions forestry yields a higher interest on the invested capital than agriculture. If such is the case, the land may be called *absolute forest land*. Generally speaking, good land yields a higher percentage under agriculture and inferior land under forestry.

Apart from the purely financial aspect, there are other considerations which influence the investment, or otherwise, of capital in forestry. Of these, the following may be mentioned:—

(1.) Newly created forests do not give a return until after the lapse of a considerable number of years, so that private proprietors frequently cannot afford planting even surplus lands.

(2.) As a rule, forests do not require to be artificially manured, because trees take from the soil much smaller quantities of mineral substances than field crops. According to Ebermayer,* an average forest crop, wood and leaves, requires annually about 54 per cent. of the mineral substances necessary for an average field crop. Of that quantity, 46 per cent. are stored in the leaves, and 8 per cent. in the wood. It follows that, if the leaves are left in the forest, a crop of trees takes from the soil only one-twelfth the quantity of mineral substances which a field crop takes in each year; in other words, almost any soil can produce timber trees without being artificially manured, especially as the annual fall of leaves and mosses growing in the shade of the trees produce a thick layer of mould, or humus, which secures excellent physical conditions in the soil, rendering artificial working unnecessary. As a natural consequence, the better classes of soil are generally allotted to agriculture and the inferior to forestry.

(3.) The weather, natural phenomena, animals and man

* "Physiologische Chemie der Pflanzen," first volume

are sources of danger to the produce of the land. In the case of field crops, the produce of only one or a few years at a time is exposed to such dangers, but in forestry the whole of the growing stock, or an accumulation of many years' produce, is constantly liable to be affected, on the other hand, a forest crop is, as a rule, less susceptible to damage than the more tender field crops. The greatest dangers which threaten the growing stock are those from fire, insects and storms. A fire may destroy the whole of the growing stock, especially in coniferous forests; insects do often considerable damage by killing or injuring the trees, while storms may uproot at one time such large numbers of trees that the material becomes almost unsaleable, apart from the fact that young woods may be seriously injured. Such damage can, however, be kept within narrow limits by careful management.

(4.) Mistakes made in the cultivation of field crops can generally be rectified after the lapse of one year, while in forestry often long periods pass before this is practicable. If, for instance, the forester selects a wrong species for planting, he will probably not find out his mistake until many years afterwards, as most indigenous species do almost equally well on ordinary soil for a series of years; those unsuited to a certain locality will, in most cases, commence falling off in growth only some twenty or thirty years after planting. It follows that greater care and skill is required in forestry than in the cultivation of field crops, so as to avoid initial mistakes.

(5.) Timber and fuel are bulky articles which do not bear transport, especially overland, to the same extent as the better classes of field crops. Hence the produce of forests must be consumed within a limited radius of the spot where it has been produced, unless water carriage is available.

(6.) The danger of trenching on capital is much greater in forestry than in other branches of agriculture. A farmer may to some extent reduce the value of his land by over

cropping and under manuring, but this can easily be detected and rectified. In forestry, the more valuable part of the capital consists of the growing stock, that is to say, material of the same class as that of which the legitimate annual return consists; hence an unscrupulous or ignorant forester can easily consume the capital, or at any rate a good portion of it, in the shape of annual income without being detected or even becoming himself aware of the fact. In this respect, again, forestry requires greater skill and care than other branches of agriculture.

(7.) Forests, more than other lands, are burdened with rights (or servitudes) and privileges belonging to third persons. The right of property is either complete or limited. In the former case, the owner can do with the property what he pleases, subject to the general laws of the country; in the latter case, his power over the property is limited by rights of third persons. Such rights may be that the third person can take produce from the forest, or use it in certain other ways, as for instance for grazing cattle, or for sport. A forest right may be attached to a person or to a piece of property, such as a house, a piece of land, etc. In the former case, it generally becomes extinct with the death of the person; in the latter, it goes with the property from one legal owner to another. As a general rule, forest rights interfere much with the management and usefulness of the property. Though in many cases unavoidable, they are injurious when looked at from the point of view of political economy; hence they should be carefully determined and their exercise regulated.

(8.) Finally, money cannot be borrowed on forest property to its full value. Generally, only the land offers absolute security, while the growing stock is not only exposed to special dangers, but can also be considerably reduced by an ignorant or unscrupulous manager without much risk of discovery for a number of years. For the same reason, forests are not fit objects for letting.

b. Labour required in Forestry.

Forests require labour in a great variety of ways which may be brought under the following three headings :—

(1.) General administration, formation, tending, harvesting, etc., or work done in the forests.

(2.) Transport of produce.

(3.) Industries which depend on forests for their prime material.

(1.) *General Administration.* — The quantity of labour required in forests differs considerably according to circumstances, the quantity and value of the produce and the consequent intensity of management. Great difficulty is experienced in obtaining accurate statistics on this point, but five days' work annually for every acre of land under forest may be accepted as an approximate estimate all round. From the available data it has been calculated that in the forests of Germany* about £8,000,000 are paid annually for administration, formation, preservation, road making, cutting of wood and collection of minor forest produce, on which about 200,000 families exist, or about 1,000,000 people. This estimate refers to forests which are already in existence, and in which fencing is done only in very rare instances. When new forests are created, additional labour is required at the outset. Nevertheless, it is beyond doubt that forests require only about one-tenth to one-twentieth of the labour necessary for land under field crops. Consequently, the conversion of fields into forests is accompanied by a reduction of work. On the other hand, the conversion of grazing lands, such as the British mountain and heath lands, into forests is followed by a considerable increase of work.

(2.) *Transport of Produce.*—Owing to the bulky nature of wood, its transport forms a business of considerable magnitude. Timber and firewood are carried by water, whenever practicable, but also extensively overland. Under

* Data from other countries are at present not available

this head, a sum of at least £4,000,000 is paid annually in Germany.

(3.) *Forest Industries.*—The labour which is required to work up the raw material yielded by forests is of a much greater extent than that employed in managing the forests and in transport. There are the workmen employed in saw mills, building, ship-building, carpentry, coach building, engineering, turning, carving, paper pulp manufacture, match making, the manufacture of cases and boxes round and square from the largest packing case to the smallest toy box, frames of sieves, drum and cask hoops, wood-wire for table covers and blinds, pencils, wooden nails, instruments, tools, plates, shovels, spoons, shoes, lasts, saddle-trees, brushes, harrows, gun-stocks, toys of thousands of patterns and endless other branches of industry, some of which can only exist in and around extensive forests. The wages earned under this head amount in Germany to something like £30,000,000 a year, maintaining about 600,000 families, or 3,000,000 people.

Taking now the three heads of labour together, it has been estimated that something like 12 per cent. of the population of Germany is employed in forest work, transport of forest produce and the working up of the raw material yielded by the forests.

An important feature of the work connected with forests and their produce is that a great part of it can be made to fit in with the requirements of agriculture; that is to say, it can be done when field crops do not require attention. Hence forest work offers an excellent opportunity to the rural labourer or small farmer of earning some money when he has nothing else to do, and when he would probably sit idle if no forest work were obtainable. It would be a considerable help to agriculture if work in fields and woods were done by the same labourers, the former in spring, summer and autumn, and the latter in winter. Such an arrangement would considerably reduce the cost of production of field

crops. Hence the importance of putting a certain proportion of the land, not required for field crops, under forest.

It is perhaps not expecting too much that afforestation will yet help to meet the difficulty of providing work for the unemployed during winter. At any rate, afforestation would require a considerable quantity of labour and thus materially help to reduce the number of the unemployed.

CHAPTER II.

INDIRECT UTILITY OF FORESTS.

A PIECE of land bare of vegetation is, throughout the year, exposed to the full effects of the sun and air currents and the climatic conditions which are produced by these agencies. If, on the other hand, a piece of land is covered with a growth of plants and especially with a dense crop of forest vegetation, it enjoys the benefit of certain agencies which modify the effect of sun and wind on the soil and the adjoining layers of air. These modifying agencies may be shortly enumerated as follows:—

(1.) The crowns of a full crop of trees provide a more or less dense roof at a certain distance from the ground which intercepts the rays of the sun and the falling rain, obstructs the movement of air currents and reduces radiation of heat during the night.

(2.) The leaves, flowers and fruits, augmented by certain plants which grow in the shade of trees, form a layer of organic matter, or humus, which protects the soil against changes of temperature and greatly influences the movement of water and air in the soil.

(3.) The roots of the trees penetrate into the soil in all directions and bind it together, or loosen it.

The effects of these agencies have been observed and recorded from ancient times down to the present, and hundreds of pages could be filled with the record of instances in which forest vegetation has affected, or has been believed to have affected, the climate, the rainfall, the regulation of moisture, the stability of the soil, the healthiness of countries and allied matters; if quantity of evidence alone were wanted, the case might be considered as "proven." In all such

cases, however, two or more agencies were at work at the same time, and the observations were not always sufficiently accurate and direct to decide in how far the produced effect was due to the one or the other cause. The consequence, naturally, was exaggerated confidence and belief on the part of some and doubt and unbelief on the part of others. This led in modern times to the commencement of accurate observations, first by Becquerel in France, and then by Nördlinger and Krutzsch in Germany, who recorded the effects of forests upon temperature and rainfall at stations situated in, or in the vicinity of, forests. A thoroughly practical and conclusive method was, however, not introduced until the year 1867, when both in France and Germany, so-called parallel or double stations were started, one being situated inside a fully stocked forest and the other at some distance from its external boundary in the adjoining open country, all other conditions, such as elevation, soil, etc., being as nearly as possible the same in both cases. Ebermayer started seven double stations of this kind in various parts of Bavaria. Switzerland soon followed with three double stations in the Canton Bern; then Austria, Italy, Prussia, Alsace-Lorraine, Thüringia, Brunswick, Wurtemberg, Sweden and others. Similar double stations were started in India (Dehra Dun, Berar, Ajmer). In Cape Colony, observations were commenced about seven years ago. The result has been a rich crop of reliable observations. Although many questions await as yet a final solution, much has been learned and established which it is proposed to indicate in the following pages. The results of the Bavarian observations were published by Dr. E. Ebermayer in his excellent book, "Die physicalischen Einwirkungen des Waldes auf Luft und Boden," and Prof. Dr. R. Weber has subsequently brought together the more important results of all European observations in his Introduction to the second edition of Lorey's "Handbuch der Forstwissenschaft," edited by Dr. Stoetzer, published in 1903.

In order to concentrate the data into the smallest possible space, they have been arranged according to seasons in the following manner:—

Spring comprises March, April and May.
Summer ,, June, July and August.
Autumn ,, September, October and November.
Winter ,, December, January and February.

The subject of the indirect effects of forests will be dealt with under the following headings:—

(1.) Effect of forests on the temperature of the air and soil.
(2.) Effect of forests on the moisture of the air and the movement of water in nature.
(3.) Mechanical effect of forests.
(4.) Hygienic effect of forests.
(5.) Æsthetic effect of forests.

1. *Effect of Forests on the Temperature of the Air and Soil.*

a. Temperature of the Air.

The observations made at the double stations mentioned above have shown that forests, on the whole, slightly reduce the mean annual temperature of the air. The general average of all stations shows that, under the 50° northern latitude, the whole effect of a complete forest growth is a reduction of about 1° Fahr. at 5 feet above the ground and ·4° in the crowns, as compared with the temperature at 5 feet from the ground in the open; somewhat more than the average in mountainous countries and somewhat less in the plains. Evergreen trees with a dense foliage, such as silver fir and spruce, have the most powerful effect, while deciduous thin-crowned trees exercise little effect. On the whole, it is clear that there is a slight decrease of temperature in forests from the region immediately above the crown towards the ground.

Of more importance than the mean annual temperature is the mean temperature of the four seasons. Here and in all future cases a reduction in the forest is represented as minus (—), and an increase in the forest over the outside station as plus (+).

Season	Reduction of Temperature inside the Forest, in Degrees Fahrenheit, as Compared with the Temperature at 5 Feet above the Ground in the Open Country	
	At 5 feet above the Ground	In the Crowns of the Trees
Spring	− 1·24	− ·59
Summer	− 2·54	− 1·48
Autumn	− 1·13	− ·41
Winter	− ·61	+ ·05
Mean of Year	− 1·04	− ·41

These data show that the difference of temperature is greatest in summer, smallest in winter, and that spring and autumn stand about half-way. As to the crowns of the trees, the temperature is even slightly higher in winter than that of the air outside.

It is of interest to examine the maximum and minimum temperature during the twenty-four hours of the day. The following figures give the differences calculated from the Bavarian and Wurtembergian observations :—

Season	Differences of Temperature between Forest and Open Country at 5 Feet above the Ground in both cases, in Degrees Fahrenheit.		
	Minimum at Night	Maximum, Early Afternoon	Range of Difference
Spring	+ ·81	− 3·87	4·68
Summer	+ 3·15	− 7·42	10·57
Autumn	+ 2·59	− 4·00	6·59
Winter	+ ·95	− 1·96	2·91
Mean of Year	+ 1·87	− 3·91	5·78

It will be observed that the temperature in forests is higher during the night and lower during the day than on open ground; the difference is most pronounced in summer and next in autumn. This leads to the conclusion that forests tend to moderate the extremes of heat and cold. In order to illustrate this further, the following data are given which show the difference between the temperature inside and outside the forest in July and January, respectively the hottest and coldest months of the year. The figures represent the averages of the Prussian observations made during ten years:—

Height at which Measured	Difference of the Absolute Maxima of Temperature in *July*, Mean of 10 Years	Difference of Absolute Minima of Temperature in January, Mean of 10 Years	Range of Difference
At 5 feet above the ground	− 5 87	+ 2 70	8 57

These figures show that the maximum temperature of forests, situated in a climate like that of Northern Germany, may be lowered in July by 5·87° at 5 feet above the ground, and the lowest temperature in January may be raised by 2·70°. The detailed observations of the different stations show further that the above effect depends greatly on the geographical position and the extent to which the localities are exposed to, or protected against, air currents. The effect differs also considerably according to species, as the following data will show:—

Species	Reduction of Highest Temperature in July	Increase of Lowest Temperature of January	Range of Difference
In Beech Woods .	− 8 37	+ 2·12	10 49
In Spruce Woods .	− 4 61	+ 4·28	8 89
In Scotch Pine Woods	− 4·14	+ 2 12	6 26

Fully stocked beech forests reduce the extremes of the air temperature during July about twice as much as spruce or

Scotch pine woods; on the other hand, during January spruce woods moderate the extremes of cold twice as much as beech or Scotch pine woods. This is due to the dense foliage of beech in summer and its leafless condition in winter; while the leaf canopy of Scotch pine woods is always much thinner than that of spruce woods. The range of difference is greatest in the case of beech woods.

The above data indicate that forests situated immediately to the north and south of the 50° northern latitude reduce the temperature of the air in their interior, which effect communicates itself to the surrounding country owing to the continuous interchange of air between the two. The actual effect, it was thought, might be even somewhat greater than the above data show, because many of the outside stations were situated so close to the edge of the forest that their temperature was already somewhat affected by an interchange of the air. This was indicated by the fact that greater differences of temperature were observed in those cases where the outside stations were situated at a great distance from the edge of the forest. With the view of arriving at more final results on this point, a commencement was made in Austria to establish a system of so-called radial stations, that is to say, several series of points of observation which commence in the centre of a considerable block of forest and are placed in various directions, at fixed intervals, from the centre and gradually into the open country surrounding the forest. In this way, it has been ascertained that the effect of forests on the temperature of the air in the adjoining open country is very limited.

Dr. Woeikof, late Director of the Meteorological Institute at St. Petersburg, has published several series of figures, with the view of illustrating the effect of extensive forest areas on the temperature of the surrounding country. He gives the mean temperature of July for various series of places, each series being situated as near as possible on the same degree of latitude, after having reduced the data to the same latitude

and an elevation of 656 feet above the sea. The following figures are those given for two series:—

MEAN TEMPERATURE OF JULY REDUCED TO AN ALTITUDE OF 656′ IN DEGREES FAHR

On the 50th degree of Northern Latitude		On the 38th degree of Northern Latitude	
Guernsey	59·5	Lisbon	70·5
Brussels	62 6	Campo Major	76·3
Würzburg (Main valley)	68 0	Palermo	76·5
Promenhof (N.-W Bohemia)	64 4	Athens	79 2
Prague (centre of Bohemia)	68 0	Smyrna	77·9
Hochwald (Moravian plateau)	63 7	Lenkoran	74·7
Troppau	68 0	Krasnowodsk	82 0
Arvavaralja (N.-W. Hungary)	64 2		
Lemberg	65 5		
Kiew	66 2		
Charkow	68 4		
Szemipalatinsk	72·7		

Dr. Woeikof points out that the temperature rises on proceeding from the Atlantic Ocean in an easterly direction to continental countries; indeed, there is a difference of 13·2° between Guernsey and Szemipalatinsk, and of 11·5° between Lisbon and Krasnowodsk. This on the whole steady increase of temperature is here and there interrupted, a phenomenon which is ascribed to the presence of extensive forests. He points out that on the 50° of latitude the first decided fall occurs at Promenhof which has in its vicinity the extensive forests situated on both sides of the Bavaria-Bohemian frontier. At Hochwald the second fall occurs, a place which is situated close to extensive forests. Further east, at Troppau, the temperature rises again, but on entering the densely wooded valleys of the Hungarian Carpathians a third depression of temperature becomes apparent. The comparatively low temperature in Eastern Galicia, at Lemberg, is also ascribed to the presence of extensive forests, while large forests and marsh lands are found close to the north-west and north-east of Kiew. As soon as the Steppes are approached, the temperature rises rapidly. As to the places situated on the 38° latitude, it is pointed out that the temperature rises rapidly from Lisbon towards the interior until Athens is reached; at Lenkoran a

decided fall is shown, ascribed to the presence of dense forests. Similar results have been obtained in India by the late Mr. H. Blanford, by drawing a line across the Gangetic plains into Assam, Sylhet and Cachar.

These and other similar data are very interesting and suggestive of certain effects on the temperature exercised by the presence of large forests; still, they should be received with caution, because it is impossible to ascertain in how far other circumstances may have produced the reductions, such as the amount of rainfall due to other causes, exposure to air currents, presence of large sheets of water, swamps, etc.

b. Temperature of the Soil.

As the temperature of the soil follows the temperature of the air near the surface in its upward and downward movements, it is necessary to observe it at various depths. The following is an abstract of the Swiss, Bavarian, and Würtembergian observations:—

Season	Differences of Mean Temperature of Soil between Forest and Open Ground, in Degrees Fahrenheit				
	On the Surface	At 1 foot below the Surface	At 2 feet below the Surface	At 3 feet below the Surface	At 4 feet below the Surface
Spring.	−4·45	−3 33	−3·17	−2 84	−2 43
Summer	−6 89	−6 71	−6·80	−6 84	−6 64
Autumn	−2 29	−2 41	−3 02	−3 29	−3 64
Winter . .	− ·20	+ 41	− ·01	− 00	− ·29
Mean of Year .	−4 14	−3 02	−3 24	−3 20	−3·17

The following conclusions may be drawn from these figures:—In the first place, the differences in the mean annual temperature of the soil are nearly the same from 1 foot below the surface down to 4 feet. Next, it is evident that the mean annual temperature of forest soil is decidedly lower than that of soil in the open; in summer by nearly 7°, and very little in winter, while spring and autumn hold

positions half way. It should also be noted that in spring the temperature sinks from the surface down to 4 feet, and in autumn the reverse takes place,* due to the fact that the changes of temperature at the surface of the ground are only slowly transmitted to the lower layers of soil.

The effect differs considerably in the case of different species. In this respect the Swiss observations, average of 12 years, have yielded the following results:—

Season,	Difference of Temperature of the Soil Inside and Outside of Forests, according to Species.		
	Spruce.	Beech	Larch
Spring . .	−5·72	−2·47	−2·02
Summer . . .	−9·18	−6·43	−4·88
Autumn . .	−4·10	−2·99	−2·56
Winter . . .	+·16	−·16	+·59
Mean of Year . .	−4·81	−3·01	−2·21

The evergreen spruce reduces the temperature of the soil considerably more than the deciduous beech, and still more so than the larch. This difference is very important in spring, as it delays the commencement of the annual cycle of growth and reduces the danger from late frosts.

c. Temperature of Trees.

Another point of interest is that the temperature of living trees varies from that of the surrounding air.

The following differences have been found in Bavaria, in degrees Fahr.

	Spring	Summer	Autumn	Winter.	Mean
At 5 feet from the ground =	−2·27	−3·15	−1·19	−2·29	−2·21
In the crown of the trees =	−1·48	−2·11	−·67	−·72	−1·24

In Switzerland, the following differences were observed, annual averages:—

In beech woods = ...	−2·92
In larch woods = ...	−3·04
In spruce woods = ...	−4·79

* This is seen from the actual temperatures, which are not given here.

Trees are considerably colder than the surrounding air during the day, while during the night the difference almost disappears, and in some cases they are even warmer at night. The latter phenomenon is due to the rising sap which causes the temperature of the trees, at any rate at the lower end, to approach that of the soil. The thicker the trees, the more falls their temperature below that of the surrounding air.

d. Summary.

The above data seem to justify the following conclusions :—

(1.) The climate of forest countries is more equable than that of open countries.

(2.) The mean temperature of soil and air in forest countries is somewhat lower than that of soil and air in open countries.

(3.) The reduction of the temperature may act beneficially in hot countries, but it may be injurious in countries removed from the equator, where the temperature is already lower than is good for the ripening of field crops.

(4.) Vegetation awakens later in spring in well stocked forests than in open ground.

(5.) As forests moderate the extremes of temperature, plants growing under the shelter of a forest crop are less liable to suffer from late and early frosts, or from drought, than plants growing in the open.

2. *Effect of Forests on the Moisture of the Air and the Movement of Water in Nature.*

Air can hold only a certain maximum quantity of vapour, which increases and decreases with the temperature. When the maximum has been reached, and more vapour is introduced, a part becomes condensed. The *absolute* vapour in the air is measured by its tension upon a column of mercury as represented in a barometer. The proportion of the absolute to the maximum tension of vapour, which is possible at a certain temperature and pressure, is called the *relative* humidity of

the air. Although the humidity of the air depends, in the first place, upon the general distribution of heat and air pressure over the large sheets of water on the earth which governs, the direction and force of the moist air currents, the vegetation of the earth also affects the degree of humidity, chiefly because it reduces the temperature locally. That effect may be felt in the degree of humidity of the air, the amount of precipitation, the degree of evaporation and in the feeding of springs and rivers.

a. Humidity of the Air.

The observations so far available show that forests do not affect the *absolute* humidity of the air to any appreciable extent. Those made in Bavaria yielded the following results :—

Season	Mean Absolute Vapour Tension, in Inches		
	In the Open, 5 feet above Ground	In Forest, 5 feet above Ground.	Excess in Forest
Spring .	·2788	·2824	+·0036
Summer .	·4626	·4618	−·0008
Autumn .	·2806	·2886	+·0080
Winter . . .	·1820	·1918	+·0098
Mean of Year	·3010	·3064	+·0054

These figures show that the increase in the forest did not reach 2 per cent. of the quantity outside. More extended observations have since shown that the difference is even smaller, and in some cases forest air has been found to contain less absolute vapour tension than open air.

It is different with the *relative* humidity of the air. As the temperature of forest air is on the whole lower than that of open air, while the absolute humidity remains about the same, it follows that the relative humidity of forest air should

be greater than that of open air, more especially in summer. The following data will illustrate this :—

The Bavarian observations of 1868–69 gave the subjoined results, as a general average :—

Season	Mean Relative Humidity, in per cent of Saturation		
	In the Open, 5 feet above Ground	In Forest, 5 feet above Ground	Excess in Forest
Spring	74 96	80 66	+5 70
Summer	71 92	81 20	+9 28
Autumn	82 72	87 94	+5 22
Winter	84 19	89 43	+5 24
Mean of Year	78 45	84 81	+6·36

These observations show that the mean annual excess amounted to 6·36 per cent. There was, however, a decided difference according to the altitude of the stations. While the excess amounted to only 3·14 per cent. at 1,066 feet above the sea, it was as much as 8·79 per cent. at 2,956 feet elevation. Further differences have been recorded according to the species as the following data will show, representing the averages of the German observations :—

Season	Excess of Relative Humidity in Forest over the Open Country, in per cent of Saturation		
	Beech	Spruce	Scotch Pine
Spring	+1 91	+6 92	+2 93
Summer	+9 35	+8 56	+3 87
Autumn	+4 07	+7 01	+4 24
Winter	+1 73	+4 76	+2 70
Mean of Year	+4 27	+6 81	+3 42

Evergreen, dense spruce woods produced a much greater effect than the thin crowned Scotch pine, or the deciduous

beech. At the same time, the greatest effect was recorded in beech woods during summer, due to the dense leaf canopy which exists in such woods at that season.

The detailed figures show that the mean annual excess in forests ranged from 3 to 10 per cent., which explains why dry air currents striking through forests become in a short time relatively moist, so that precipitations may be caused. At any rate there can be no doubt that the formation of dew is much greater in the vicinity of forests than on open ground away from woodlands.

b. Precipitations, or Rainfall.

The question, whether, and in how far, forests affect the rainfall, is one which has been actively discussed for many years past, but so far no final conclusion has been possible. That forests can affect precipitations follows from the facts that forest air is relatively moister than air in the open, and that the trees mechanically affect the movement of the air; but, on the other hand, the rainfall depends chiefly on other much more powerful agencies in comparison with which the effect of forests is small. Numerous comparative observations have been made, but only a certain portion has so far been published, and unfortunately those which seem to indicate a decided effect of forests on the rainfall are not always very reliable. The great difficulty in comparing the results of observations at forest stations (that is to say, stations situated inside forests) with those of the ordinary meteorological stations is that elevation above the sea affects the rainfall most powerfully, because air cools on rising and precipitations become more frequent with elevation.

Although further observations are necessary before a final conclusion can be arrived at, the following data may prove interesting:—

In the Prussian system the forest stations have shown the subjoined increase of rainfall over the average rainfall of the

open country as taken from the ordinary meteorological stations:—

	Excess of Rainfall in Forest Stations over that of Open Country, in per cent of the latter Rainfall
Between Sea level and 328 feet elevation	1·25 per cent.
,, 328 and 556 feet ,,	14·2 ,,
,, 1,969 and 2,297 feet ,,	19 ,,
,, 2,297 and 2,625 feet ,,	43 ,,

These figures seem to indicate that, within a certain distance from the sea, forests have very little effect upon the rainfall in the plains, if any at all, but that their influence becomes considerable with increasing elevation in mountainous countries.

The results of 7 years' observations made at two stations near Nancy show a decided increase of rainfall in the forest. The stations are situated 1,247 feet above the sea, one in the middle of an extensive forest 5 miles to the west of Nancy, the other in an almost woodless country 6 miles to the north-east of Nancy. The results were as follows:—

	Increase of Rainfall in Forest over that in the Open, in per cent of the latter
February to April	7 per cent
May to July	18 ,,
August to October	23 ,,
November to January	21 ,,
Mean of Year	16 ,,

that is to say, an increase of 16 per cent. at the forest station.

Other evidence tending in the same direction is available, but the Bavarian observations, as well as those made during the last few years, do not justify any direct conclusion as to any increase in the absolute rainfall due to the action of forests. The increased quantity of precipitation which has been recorded in some cases may to a considerable extent be

accounted for by an increased formation of dew which is registered together with the rainfall.

On the whole, it may be said that various physical factors act towards rendering forests excellent condensers of vapour, because they have a lower temperature, a moister air and break the force of air currents. These properties are more evident in elevated positions than in low lands and in the vicinity of the sea, where they are swamped by other more powerful agencies. Absolute certainty in respect of these phenomena can only be obtained through further extensive observations.

The presence of a forest crop prevents a portion of the rainfall from reaching the ground, because it is intercepted by the crowns of the trees. The various measurements have yielded the following results:—

Stations	Quantity of Rainfall which reached the Ground in well-stocked Woods, in per cent of Total Rainfall.			
	Beech Woods	Spruce Woods	Scotch Pine Woods	Larch Woods
Prussian Stations .	76	78	73	
Bavarian Stations .	78	73	66	..
Swiss Stations	90	77	...	85

The average of the Bavarian stations shows 77 per cent. of the rainfall as having reached the ground, whereas 23 per cent. were intercepted by the crowns of the trees and evaporated or partly ran down the trunks of the trees; the latter has been found to vary from 1 per cent. to 13 per cent., according to species and the total rainfall.

c. Evaporation.

Owing to the lower temperature, the somewhat greater humidity of the air and the quieter state of the atmosphere, evaporation must be considerably smaller in forests than in the open. This has been conclusively proved by direct

observations. Those made in Bavaria and Prussia show the following results :—

Stations	Quantity of Water Evaporated from a free Surface of Water, Height in Inches			Less in Forest expressed in per cent of the total Quantity evaporated in the Open
	In the Open	In Forest	Less in Forest	
Bavarian . .	23 53	8 61	- 14 92	- 63
Prussian . .	13 16	5 98	- 7 18	- 55
Mean . .	18 34	7 29	- 11·05	- 60

These data show that evaporation in the forest was only two-fifths of that in the open country.

The effect of this action is that of the water which falls on the ground in a forest a considerably larger proportion is secured to the soil than in the open. It has been estimated that about twice as much water penetrates into forest soil as into soil in the open country. That water is available to be absorbed by the roots, while any balance goes to the underground reservoirs, and helps to feed springs. Of considerable importance in this respect is the covering of forest soil. Dr. Ebermayer's observations on this point, extending over 5 years, show the following results :—

	Parts.
Evaporation of water from soil in the open placed at	= 100
Evaporation from forest soil, without leaf-mould .	= 47
,, ,, ,, ,, with a full layer of leaf-mould . . .	= 22

In other words, forest soil without leaf mould evaporated less than half the water evaporated in the open, while forest soil covered with a good layer of humus evaporated even less than one-fourth of that evaporated in the open.

The result of these peculiarities is that forest soil retains, after allowing for evaporation, more water, than soil in the open, although some 23 per cent. of the rainfall is intercepted

by the crowns of the trees, of which a considerable part evaporates and is thus lost to the soil. On the other hand, the roots of the trees take considerable quantities of water from the soil; hence forest soil may be less moist in the root region than soil in the open. At the same time, open land covered with grass and weeds, as it usually is when not cultivated, allows less water to penetrate into the soil than forest soil, while field crops take considerably more water from the soil than forest trees. The conclusion is, therefore, justified, and it is proved by every-day experience, that forests act most beneficially upon the preservation of moisture. In this respect a great difference is produced by altitude. In lower situations, evaporations from the soil and by the leaves may consume all the water which reaches the ground. With rising altitude, the percentage of the rainfall thus consumed becomes smaller, so that an increasing proportion of the rainfall sinks into the ground and becomes available for the feeding of springs. Hence mountain forests have from time immemorial been looked upon as the preservers of moisture. The presence or absence of springs in a given locality, however, depends chiefly on the geological formation. Sandstone and chalk formations are poor in springs, because the water sinks rapidly to a considerable depth, while other formations are generally rich in them.

3. *Mechanical Effect of Forests.*

The mechanical effect of forests makes itself felt chiefly in regard to the distribution of the rain water, the preservation of the soil on sloping ground, the binding of shifting sand, the prevention of avalanches and the moderation of air currents.

a. Feeding of Springs and Rivers.

Most of the rainwater falling on a bare slope rushes down into the nearest watercourse in a comparatively short time, thus causing a rapid rise in the level of the stream. Only a

comparatively small portion sinks into the ground, so as to become available for the feeding of springs. Of the rain falling over a forest close on one-fourth is intercepted by the crowns of the trees, and the other three-fourths fall upon a layer of humus which possesses a great capacity of absorbing water and of retaining it for a time. It has been shown, for instance, that mosses of the genus *Hypnum* which grow under the shade of conifers can absorb up to five times their own weight of water, and peat mosses of the genus *Sphagnum* up to seven times; again, the leaf-mould to be found in a middle aged well preserved beech wood can absorb and retain for a time a considerable quantity of water. Part of the water thus absorbed penetrates into the ground, is taken up by the roots of trees or becomes available for the feeding of springs, while the rest gradually finds its way into the nearest stream. In this manner, well preserved forests must have a decided effect upon the sustained feeding of springs and the moderation of sudden floods in rivers. When, however, the humus has been saturated with water, and rain continues, the effect of forests as regards inundations must cease, because the additional water follows the law of gravity and finds its way into the valleys. Hence the effects are of limited extent, a matter which has frequently been overlooked in discussing the subject. In order to moderate inundations to any appreciable extent, it would be necessary to keep a very large proportion of the catchment area under forest, and even such a measure would only afford protection to a certain extent.

b. Protection of the Soil.

Water rushing down a bare slope possesses a great mechanical power, by means of which it loosens the soil and carries it down hill. In this way, landslips are often caused, ravines are formed and fertile land, situated at the foot of the ravines, may be covered with silt and rendered valueless. Frequently, the *debris* collects in rivers and forms obstructions which are followed by a diversion of the bed and erosion of

fertile lands. The rate at which this process proceeds depends on the geological origin and the formation of the surface, the less binding the soil and the looser the formation, the greater the damage will be. If, on the other hand, such a slope is covered with a well preserved forest, the roots of the trees and the layers of humus keep together and protect the soil against the action of water; besides, the crowns intercept and retain, at any rate for a time, a considerable portion of the water. On the whole, a series of obstacles are opposed to the movement of the water, which reduce its velocity and force, or at any rate divide it into numerous small channels. The beneficial effect of tree vegetation in this respect can be observed in most mountain ranges, and especially in the Alps from France to Austria. Wherever, in those parts, extensive deforestation has taken place, the consequence has been the gradual formation of a series of torrents in all places where the surface did not consist of hard rock; the *debris* brought down has covered more and more fertile land at the base of the torrents, and this evil has grown to such an extent that not only in France, but also in the other Alpine countries, great efforts have been made to re-afforest the denuded areas at a great outlay. When once the evil has been created, immediate afforestation is not possible, it must be preceded by the construction of dams, dykes, walls, etc., to steady the soil, until the young forest growth has had time to establish itself and once more lay hold of the surface soil.

The importance of maintaining a complete cover of vegetation in all such cases was recognised many years ago, so that already in the Middle-Ages so-called "Protection Forests" existed which the then existing laws protected against devastation. Although the effect here described is perhaps most complete in the case of a well-stocked forest, similar effects are produced if the soil is covered in other ways, as, for instance, by a dense growth of heather, by turf, etc.

Forests protect the soil not only in the hills, but also in low lands, wherever it consists of so-called moving or shifting

sand, along the sea coast as well as in the interior of countries. The action in this case is due, partly to their moderating the force of the air currents, and partly by keeping the soil together through their roots, by the formation of humus and the retention of moisture. In this way, the Landes of France have from a dreary waste been converted into extensive forests intersected by cultivated fields and vineyards.

c. Protection against Avalanches.

Although most avalanches in the higher hills originate above the upper limit of tree growth, there are many cases where the presence of a well-preserved forest protects towns and villages lying below them by preventing the formation of avalanches, or by stopping their forward movement and increase whilst they are still small. Hence many forests in the Alps are maintained as a protection against avalanches.

d. Protection against Air Currents.

Forests break or moderate the force of air currents and in this way afford protection to lands lying beyond them against cold or dry winds. Whether such effect is beneficial or otherwise, depends on the geographical position, the local climate and the season of the year. Woodlands afford also shelter to cattle, game and useful birds. Their importance in this respect should not be overlooked: forest grazing is frequently of greater value than grazing on open ground; the presence of birds, which are the great enemies of injurious insects, depends often on that of woodlands.

4. *Hygienic Effect of Forests.*

Forests, in forming a substantial part of the vegetation of the earth, are an important agency for the production of oxygen obtained by the decomposition of carbon dioxide. Direct observations have also shown that forest air (like sea air) is much richer in ozone than the air of open countries,

and especially of towns. Professor Ebermayer gives the following results, the maximum contents of ozone being indicated by 10 and complete absence by 0:—

Stations	Contents of Ozone in the Air			
	Spring	Summer	Autumn	Winter
Average of the six Bavarian double stations situated inside and in the vicinity of forests	8 20	7 71	7 99	8 36
Aschaffenburg, town	6 81	6 24	5 35	6 04
Leipzig, town	5 42	6 93	3 65	3 37
Zwickau, town	3 23	3 11	2 21	1 81

The difference between forest countries and towns is greatest during winter, which seems to show that the presence of ozone does not depend on the action of the leaves. It was also found that the air in the interior of forests, near the ground, contained slightly less ozone than along the edges of the woods, which may be due to the presence of large quantities of decaying matter (humus) in the forest.

As forests produce oxygen and ozone and protect human habitations against injurious air currents, they have been held to exercise a beneficial effect upon the healthiness of adjoining lands. Instances are not wanting, where forests are said to have given protection against the germs of malaria, but there are others, where they are believed to have had the opposite effect. As far as India is concerned, in some cases the medical authorities of military cantonments ordered forests to be planted and in others to be cut down. According to modern investigations, ozone is believed to have no hygienic effect; more especially its presence or absence is said not to influence the development of epidemic diseases. If this is so, the salutary effect of forest air is probably due to the absence of dust, smoke and injurious gases, to the small number or total absence of microbes and the greater tranquillity of the human mind.

5. *Æsthetic Effect of Forests.*

As forests increase the artistic beauty of a country, they must influence the character of the people, especially as they are favourite places of recreation. Many of the British woodlands were created, or are maintained, for their æsthetic effects. These should not be underestimated. They increase the attraction which a country life has upon the people, and thus act as agents against otherwise deteriorating influences, such as people will be exposed to if they immigrate into the big towns.

CHAPTER III.

SUMMARY OF CONCLUSIONS.

THE various ways in which forests exercise an influence in the economy of man and of nature may be summarised as follows:—

(1) Forests supply timber, fuel and other forest produce (valued at £200,000,000 in Europe alone).

(2.) They offer a convenient opportunity for the investment of capital and for enterprise.

(3.) They produce a demand for labour in their management and working, as well as in a variety of industries which depend on forests for their raw material.

(4.) They reduce the temperature of the air and soil to a moderate extent and render the climate more equable.

(5.) They increase the relative humidity of the air and tend to reduce evaporation.

(6) They tend to increase the precipitation of moisture.

(7.) They help to regulate the water supply, produce a more sustained feeding of springs, tend to reduce violent floods and render the flow of water in rivers more continuous.

(8.) They assist in preventing erosion, land slips, avalanches, the silting up of rivers and low lands and arrest shifting sands.

(9.) They reduce the velocity of air currents, protect adjoining fields against cold or dry winds and afford shelter to cattle, game and useful birds.

(10.) They assist in the production of oxygen and ozone.

(11.) They may under certain conditions improve the healthiness of a country.

(12.) Finally, they increase the artistic beauty of a country and thus exercise a beneficial influence upon man.

Whether, and in how far, these effects are produced in a particular country depends on its special conditions. As regards the *direct* effects, enumerated under (1), (2) and (3), the following considerations are of importance in deciding whether existing woodlands should be preserved, or new forests created:—

(1.) The position of the country, its communications with other countries, and the control which it exercises over other countries.

(2.) The quantity and quality of substitutes for forest produce available in the country.

(3.) The value of land and labour and the returns which land yields if used for other purposes.

(4.) The density of population.

(5.) The presence or absence of waste land.

(6.) The amount of capital available for investment.

A country so situated that the importation of wood and other forest produce is comparatively easy and cheap (sea-bound, traversed by navigable rivers coming from countries which are rich in forests, or intersected by numerous railway and other means of communication), or which has control over other countries, as for instance colonies rich in forests, can dispense with extensive forests. In a country which is rich in coal, lignite, or peat, the production of firewood is of subordinate importance. Where iron or other substitutes for timber are available in sufficient quantity and at a low rate, forests are not required to the same extent as in a country which does not enjoy such advantages. Where land under field crops yields, even if forest produce is imported, a higher interest on the invested capital than under forest, the latter would, in this respect, be undesirable. If the population of a country is very dense and all land is required for food, forests would be out of place. Where, on the other hand, waste lands exist which are not required or are unsuited for field crops, and where the population is at the same time in want of additional work, it may be advisable to create forests so as

to increase the returns from surplus lands, and to provide occupation through the operations connected with the administration of the forests and the industries which the existence of forests tends to create.

In considering the advisability, or otherwise, of afforesting a country, with special reference to the *indirect* effects of forests, the most important points are its climate and configuration. The nearer to the equator the more important becomes, as a rule, the forest question, and the further removed from it the less important. While forests may in a hot country, with distinct wet and dry seasons, be absolutely necessary for the mitigation of extreme heat and dryness during certain parts of the year and the regulation of the flow of water in springs and rivers, they may be injurious in a northern country which is already too cold and damp. Similarly, a continental country may require forests, while a seabound country may, apart from wind-breaks, be better without them as far as climatic considerations are concerned. A mountainous country is much more in need of forests than a low-lying country on account of their beneficial action as regards landslips, avalanches, the carrying away of débris, the silting up of rivers and low lands, sudden floods and the sustained feeding of springs. As regards the protection against strong winds and shelter to cattle and useful birds, forests act beneficially in any country.

On the whole, no general rule can be laid down showing whether forests are required in a country, or what percentage of the area should be so used. The forest question must be determined on the special circumstances of each country. By way of illustration the areas at present under forest in a number of countries are shown in the table on the next page. Considerable differences exist in respect of the data available for several of the countries. In all such cases, the data which appeared most reliable have been entered in the statement. The percentage of forest area varies from 48 to 4 per cent. and the area per head of population from 9·9 to ·1

acres. This shows that the general conditions in the various countries must make different demands in respect of afforestation. Servia,* Russia, Sweden and Norway may as yet have more forest than they require for their own population. On the other hand, Great Britain and Ireland, Germany, Denmark,

Countries	Area under Forest, in Acres.	Percentage of Total Area of Country under Forest	Forest Area per Head of Population, in Acres	Distribution of Forest Area according to Ownership, in per cent of total Forest Area		
				State and Crown Forests	Forests of Corporations, Endowments, etc.	Private Forests
Servia . . .	5,166,000	48	3 8	—	—	—
Russia, in Europe .	527,427,000	42	6 1	60*	40	
Sweden .	42,366,000	35	9 1	20	80	
Hungary	22,693,000	35	1 4	16	52	32
Austria Proper	24,161,000	33	1 1	7	18	75
Germany .	34,350,000	26	6	33	19	48
Norway	18,920,000	25	9 9	12	3	85
Turkey (including Bulgaria Bosnia and Herzegovina) .	20,512,000	22	3 5	—	—	—
Roumania	4,883,000	22	9	—	—	—
Italy	14,235,000	22†	5	4	43	53
Switzerland	1,930,000	19	7	4	67	29
France	20,750,000	16	6	11	23	66
Greece .	2,026,000	16	1 2	80	—	20
Belgium	1,300,000	17	2	5	33	62
Holland	554,000	7	1	—	—	—
Spain	7,742,000	6	4	82‡	—	18
Portugal	1,166,000	3	2	—	—	—
Denmark	477,000	4	1	—	—	—
Great Britain and Ireland	3,030,000	4	1	2	—	—
Total for Europe	753,688,000	30	2 5	—	—	—
United States of N America .	380,000,000	17	7 6	—	—	—
East India, British	140,000,000§	22	6	100	—	—

* Approximate † Includes olive woods

‡ Includes probably the Corporation forests

§ State forests under the management of the Forest Department; area of other forest not known

Portugal, Spain, Holland, Belgium, France and Italy have a smaller forest area than is necessary to supply them with a sufficient quantity of forest produce. At the same time, most of them are seabound countries, and consequently subject to

* The area of forests in Servia is probably considerably smaller than that given in returns.

conditions which differ altogether from those found in continental countries; many of them are under the influence of moist sea winds, and all are favourably situated in respect of importation by sea.

The state of ownership is intimately connected with the area under forest in a country. Forest owners may be grouped into the following three great classes:—

(*a*) The State or the Crown.

(*b*) Corporations, Endowments, etc.

(*c*) Private persons.

Where, apart from the financial aspect and the supply of work, forests are not required on account of their indirect effects, and where importation from other countries is easy and assured, the Government of a country need not, as a rule, trouble itself to maintain or acquire forests. But where the opposite conditions exist, that is to say where forests are necessary to produce climatic and mechanical effects, and where the cost of transport over long distances becomes prohibitive, or where future imports are uncertain, a wise administration will take measures to assure the maintenance of a certain proportion of the country under forest. This can be done, either by maintaining or constituting a certain area of State forests, or by exercising a certain amount of control over corporation and private forests, or by measures which encourage afforestation by private proprietors. How this question should be treated will be explained in the next part of this volume.

PART II.

THE STATE IN RELATION TO FORESTRY.

THE STATE IN RELATION TO FORESTRY.

As indicated in the first part of this volume, forestry has for its primary objects the production of forest produce and the realisation of certain other effects. Hence forestry is an industry based upon the productive power of the soil, which satisfies certain requirements of the inhabitants of the earth. This industry differs from others, and especially from the production of field crops, chiefly by the long time which is required for the maturing of the produce. While that process takes, in other industries, only a comparatively short time, forest trees may require one hundred and more years before they reach the size necessary for a particular purpose. Under these circumstances, *continuity of action* extending over a long period of time is an essential condition for successful forestry.

The industry also requires considerable areas, whenever a steady annual yield is expected, because there must be woods of various ages, and each wood must be of a minimum size. Competent managers, moreover, are expensive, and in order to utilise them fully they must administer considerable areas. The construction of means of transport, such as roads, tramways, forest-railways and other works of this class, pays only if considerable quantities of produce are moved over them. These and other considerations make it clear that successful forestry conducted on economic principles is, as a rule, possible only on large properties, such as may be held by the State, communes, other corporations and sometimes by wealthy private persons. Only in these cases is the management fairly independent of personal or temporary fancies of the owner.

The task of the industry is to do justice to true economic

principles, in other words, to increase steadily and to the highest practicable degree the productiveness of all natural forces and of the capital invested in the business. In some cases, the object of management centres in a high return, in others, different objects are aimed at In the latter cases, the sacrifice made from a financial point of view should be duly compensated for by other benefits.

The scientific treatment of the economic position, which forests occupy in the State and in Political Economy, is explained in *Forest Policy*. It deals with the social aspect of forestry, and it considers specially the duties which the State has to fulfil as regards forests, so that they may in the highest possible degree answer the demands which are made on them in the interests of the community as a whole

These duties will be shortly indicated in the following pages; they vary according to the objects for which forests are maintained, and the proprietorship. Accordingly, the subject may be dealt with under the following headings:—

Chapter I. DUTIES OF THE STATE IN REGARD TO FORESTRY.
„ II. PROTECTION FORESTS.
„ III. STATE FORESTS.
„ IV. FORESTS OF COMMUNES, CORPORATIONS, ETC.
„ V. PRIVATE FORESTS.

In dealing with this subject the following works have been utilised:—

(1.) "Forest Policy," by Dr. I. Lehr, in Lorey's "Handbuch der Forstwissenschaft";

(2.) "Forest Policy," by Dr. A. Schwappach, in Frankenstein's "Handbuch der Staatswissenschaften"; and,

(3.) "Forest Law," by B. H. Baden-Powell, C.I.E., Hon. M.A., Oxon.

CHAPTER I.

DUTIES OF THE STATE IN REGARD TO FORESTRY.

True human happiness can be secured only by social intercourse. The latter, however, imposes restrictions on the individual; it demands institutions of such a nature that, on the one hand, sufficient latitude is afforded for personal development, activity and individual deeds, and, on the other hand, that an individual may not disturb or destroy the sphere of action of his neighbour. This object can be realised only by institutions which have for their object the furtherance of the common interests, in subordinating the interests of the single individual to the joint interest of the whole community whenever the two clash.

The logical consequence of such an arrangement is that all men should have an equal chance of personal development, and that all individuals should equally share the fruits of such institutions. This, however, is not in accordance with what actually took place in former times and is still taking place in the world. History shows that might has always been an important factor in all social arrangements; certain classes of society have always striven to appropriate for themselves more than their share of social production, and to subordinate other classes to their own will. Frequently, such subordination has been sanctioned by laws. For laws are often made by the more powerful classes.

With the development of culture and the consequent creation of new conditions, the formerly subordinated classes gradually asserted their rights, and participated more fully in social life, until their demand for equality had to be admitted.

They were thus created free citizens in all civilised States, possessing equality before the law and to a certain extent equal political rights; in the latter respect, some differences still exist due to position and property.

The forces by which public order is maintained are (1) education, moral sense and custom which assert themselves in an unobtrusive manner, and (2) social associations which are partly voluntary, that is to say, it is free to any one to join or not, and partly compulsory. Of the latter, the most important is the State which represents all inhabitants who live within its limits.

The State authorities exercise the supreme power within the limits of the State territory to whom all persons and goods are subjected; they make laws which are binding on all alike.

The State has various duties to perform. In the first place, it must make laws which *limit* the action of the individual, with the object of securing their rights to all citizens and of protecting them against illegal interference of any kind; it must also maintain such laws. The Government of the State rests sometimes with the ruler only; in other cases the representatives of the people exercise the supreme power; between these extreme cases many intermediate forms are found. By the general laws of a country limits are drawn, within which full liberty is given for individual development and through it for the advancement of the welfare of the whole community.

The action of the State must frequently also aim at directly *furthering* the welfare of the people, by removing obstacles which obstruct the development of the individual, or by creating institutions which strengthen his working power. In this respect, State action is called for where the power of the individual is not sufficient to attain objects which are essential for social development; where the advantages to be derived are not sufficient to induce individuals to take up the task; where free action on the part of the individual endangers the interests of the community as a whole, *or where it is*

preferable, that the State should guard the interests of the community. The last occurs when permanent institutions must be made independent of momentary personal fancies or wishes; in such cases the State alone affords sufficient guaranty for continuity of action in a given direction.

From the above remarks it will be seen that there are certain matters of general interest which are better kept under the care and management of the State, while others may be left to the free activity of the individual. The limits between the two classes are by no means easy to draw, nor can they be fixed once and for ever; they depend on the degree of civilisation and education and the character of the people, as well as on the industrial condition of the country.

Applying now what has been said above to the case of forestry, it follows that the State must interfere, sometimes *limiting* and sometimes *furthering*, whenever the welfare of the community as a whole demands it; beyond that it should not go. The nature and extent of the measures which the State should take in this respect depend on—

(1.) The special requirements of the country, as determined by the general culture of the people and the situation and nature of the country.

(2.) The nature of the proprietorship of the forests.

As long as the forests are not of national importance, or are in the hands of proprietors who offer a sufficient guarantee for a suitable management, interference by the State is not called for. On the other hand, it becomes, as a rule, necessary in cases like the following:—

(1.) Where the interests of the community demand the maintenance and suitable treatment of forests which belong to a large number of small proprietors.

(2.) Where the existing legal conditions (servitudes, joint property, etc.) produce conflicting interests.

(3.) Where the existing means of communication are not sufficient to carry the necessary forest produce at a reasonable rate to special localities.

(4) Where forests are necessary on account of their indirect effects.

Accordingly, matters differ in the various civilised States of the earth. In some, no State control whatever is exercised over forest property, in others it is restricted to protection forests and to State forests, in others it extends to communal forests and in others again to private forests.

The control of the State over forests, whatever the proprietorship may be, must be regulated by laws. In some cases, such laws are incorporated with the general laws of the country, in others, special forest laws have been passed. In either case, such laws must provide for the following matters:—

(1.) Determination of the areas which shall be considered forest and are as such subjected to the forest laws, a distinction being made between:—

(*a*) Protection forests, to be described in the next chapter.

(*b*) State forests.

(*c*) Forests belonging to corporations, communes, villages, etc.

(*d*) Private forests.

(2.) Determination, regulation and commutation of forest rights, and prevention of the creation of new rights.

(3.) Protection of the forests against unlawful acts, such as theft or damage; prevention of such offences; and punishment of persons who have committed forest offences.

(4.) Protection of forest produce in transit.

(5.) Constitution of a staff of forest officers, provision to invest them with suitable legal powers and determination of their duties and liabilities.

The details of these matters cannot be dealt with in this place, and the reader is, therefore, referred to law books on the subject; more especially to Baden-Powell's "Forest Law." The following chapters will indicate, whether, and in how far, State interference is called for under the different forms of proprietorship and in the case of protection forests. As the latter are most in need of interference on the part of the State, they will be taken first.

CHAPTER II.

PROTECTION FORESTS.

By protection forests, in the present sense, are understood forests which must be maintained as such on account of their influence upon the welfare of the community as a whole, more especially for the protection against natural phenomena and the effect upon the climate. Such forests may be the property of the State, communes, or private persons.

The law of the country should provide for the formation of protection forests, if they are required for one of the following purposes:—

(1.) Preservation of the soil, especially on hill sides and where shifting sands occur, so as to prevent erosion, denudation, landslips, the formation of ravines, the silting up of fertile lands at the foot of hills and of river beds, or the extension of shifting sands near the sea shore as well as inland.

(2.) Preservation and regulation of the water supply in springs and rivers, so as to secure an even flow and prevent floods, or, where the water is required for irrigation, power, or other purposes, to reduce evaporation in the catchment areas.

(3.) Protection against injurious air currents, such as gales, cold or hot winds.

(4.) For the benefit of the public health.

(5.) For the prevention of avalanches.

(6.) For the defence of the country.

Protection forests may be subject to special regulations in respect of:—

(*a*) the manner of cutting and working generally;

(*b*) the execution of planting or sowing;

(*c*) the construction of accessory works, such as dams, weirs, erection of fascines, fixation of shifting sands, etc.;

(*d*) the regulation or prohibition of cattle grazing, removal of litter and similar matters.

The procedure followed in declaring protection forests differs considerably in the various civilised States, in some cases an official selection of protection forests has been made; in others protection forests are declared from time to time, as necessity arises; in some cases the proprietor may demand that his forest be declared a protection forest.

Before the State is justified in interfering or proceeding to the declaration of protection forests and thus imposing restrictions on their management, certain conditions must be fulfilled, such as the following:—

(*a*) The object to be realised by the restrictions must be of public importance.

(*b*) The advantages to be derived from the restriction must be greater than the disadvantages caused thereby.

(*c*) The realisation of the object must be assured without another cheaper way being available.

(*d*) Compulsion should be resorted to only, if private efforts are unable to realise the object in view

(*e*) Compulsion must not go beyond what is actually unavoidable. It is always desirable to let it be preceded by an effort at a friendly settlement of the difficulty. In cases of urgent danger, however, prompt action must be taken.

(*f*) Owners, who are subjected to loss or curtailment of rights, should be compensated. Such compensation is not necessary in cases, where damage is to be prevented for which, if it occurs, the owner of the forest would be responsible. Considerable difficulty is frequently experienced in deciding who shall pay the compensation, or how it is to be divided amongst those who are liable to pay it. (Protection against wind, shifting sand, preservation of moisture, etc.)

The measures to be taken against threatening dangers differ very much. In some countries it is considered sufficient to

maintain existing forests; the authorities are satisfied with insisting on the areas remaining forest and their not being devastated. In other countries, afforestation of bare lands can be enforced.

In order to prevent too great a division of property, that of protection forests should be subject to State sanction. If the proprietors are already very numerous, it is advisable to constitute an association and, if necessary, power should be given to enforce this.

The State should have authority to undertake the management of protection forests, if the object in view cannot be realised in any other way.

If restrictions prove insufficient, or too cumbersome, expropriation may be considered. It has the advantage that it renders awkward compulsory restrictions unnecessary, leads to a reduction of the cost of supervision, and simplifies the question of compensation.

Expropriation must be provided for by law. Objects of expropriation are property and rights over property which obstruct public objects.

The cases, in which expropriations are admissible, should be fully detailed in the law. The decision, whether the law is to be put into operation, should ultimately rest with the law courts, though this is by no means the case in all countries.

If the area to be expropriated forms only part of a property, it may be necessary to take up the whole, when for instance the remainder cannot economically be utilised.

The compensation should be equal to the value of the property or the right, as the case may be; in other words, it should at least be equal to the amount which can be obtained by private sale in the open market; in some cases a certain percentage over and above such value is paid. The compensation consists generally of money. If both parties agree, other property, such as forests or fields, may be given in exchange for the area expropriated.

CHAPTER III.

STATE FORESTS.

THERE exists hardly a country in which the State, or the Crown, does not own forests. As a rule, such forests were originally at the disposal of the ruler of the country, but by degrees they became in most cases State property. The present chapter deals with the latter class of forests which in many countries form an important part of the national property. A reference to page 50 will show that in some European countries up to 80 per cent. of the total forest area belongs to the State, whereas in a few cases only the State owns no such property. For India, it has been estimated that more than half the total forest area belongs to the State.

As the State appears in a double capacity in this respect, namely as the power which lays down the general forest policy of the country and as the proprietor of part of the forest area, the question may naturally be asked, whether it is desirable that State forests should be maintained, or whether it is preferable that such forests should be held by private persons. Reasons have been advanced for and against the maintenance of State forests, the more important of which must be shortly indicated.

1. *Reasons for Maintaining State Forests.*

These may be arranged as follows:—

(*a*) *Reasons based upon certain peculiarities of the forest industry which enable the State, in preference to private persons, to maintain a suitable management of the forests.*—The view has frequently been expressed that in forestry private interests do

not coincide with those of the community as a whole. The former centre in the realisation of the greatest profit, which may demand the production of only small material, or even the actual devastation of the forest, whenever the capital represented by the growing stock and the soil can be more profitably utilized in other ways.

The State, on the other hand, is more interested in the realisation of a sustained yield, so as to provide for the requirements of the nation, especially as regards timber of large size. The latter, it is said, leads generally to unfavourable financial results. This is, no doubt, true in many cases, but not in all, or for ever; large sized timber, required for special purposes, may rise in price sufficiently to make its production financially remunerative.

In State forestry, it is said, the interests of the proprietor and of the community as a whole are brought into harmony, even if the management yields only a low rate of interest on the capital value of the forests. The State is assumed to last for ever, and the outlay on formation, regeneration and tending of the forests will be reimbursed, even if after a considerable space of time. Moreover, the State should not look merely at a high rate of interest, because it is also interested in the production of a sufficient quantity of produce, or in obtaining it from the smallest possible area, so that the remaining, and better, part of the land may be available for other purposes; any financial loss caused thereby, it is argued, is merely apparent, since the outlay goes to the people in the shape of wages, and the apparent loss is more than made good by the flourishing of industries which produce a high taxing capacity of the people. The latter argument is, however, unsound; industries to be in a healthy condition must be conducted on financial principles; though temporary help may be wanted for young industries, when once started they must stand or fall on their own merits.

A further argument under this head is that forestry can be profitable only if conducted on large areas; hence it requires

a large capital which is only in exceptional cases at the disposal of private parties. This argument holds good in many cases, but by no means in all.

Finally, it is said, that forestry requires little labour while control is easy, and that it offers little or no opportunity for speculation; hence it is specially adapted for State enterprise and less so for a private industry

(*b*) *Reasons of State Finance.*—State forests are considered to be a suitable source of public revenue; the income is steady, sustained and safe. At the same time it is an income the payment of which is not felt by the people.

State forests also form a reserve capital which can be made available in times of special need, either by pledging the property against loans, or by extra cuttings. As far as the last point is concerned, it must not be overlooked that in times of need prices generally rule low, so that extra cuttings would not be indicated.

(*c*) *Social Political Considerations.*—The possession of State domains increases the credit of the State. The maintenance of State domains also prevents the accumulation of too much landed property in a few private hands. Moreover, if a certain proportion of the forest area is the property of the State, all supervision and control of private forests can be abolished.

(*d*) *The State, by owning and managing a certain area of forests, can do justice to various tasks and objects which do not directly result in income.*—This argument refers to protection forests, the supply of forest produce of a certain description and quantity, supply of work in poor districts and similar matters. As regards the latter point, it must be noted that labour will be required, whether the forests belong to the State or to private parties, though there may be some difference in the quantity.

2. *Reasons against Maintaining State Forests.*

These may be arranged under the following four heads:—

(*a*) *Danger of a mischievous one-sided utilization of State forests on the part of Government.*—Owing to the receipts from

State domains, the Government is to some extent, or for a time, independent of the parliamentary power to sanction taxes. Or, the Government may grant privileges to members of the party which supports it and withhold them from its opponents. These arguments have, however, little or no weight nowadays.

(*b*) *The possession of State domains may lead to a conflict of duties on the part of Government.*—It is below the dignity of the State if the Government and private persons compete in the open market, or contend in the law courts

(*c*) *State domains are considered injurious*, because they interfere with the natural development of national industries and reduce the opportunity for paying enterprise on the part of private persons.

(*d*) *State forestry is said to be financially undesirable*, because the State cannot manage forests as profitably as private persons. This refers less to the technical management than to the preparation and disposal of the produce. As regards the latter, the objection carries no doubt some weight.

3. *Conclusions.*

The above remarks justify the conclusion that, on the one hand, State proprietorship need not be extended to all forests, and on the other, there is no reason why the State should, as a matter of principle. dispose of its forests. This holds good as long as State forests are either protection forests, or yield an adequate income. If neither is the case, then conversion or sale may be indicated.

Purchase of forests by the State may be recommended when they are required as protection forests, when already existing Government estates require to be consolidated, where additional work is wanted in congested districts, where waste lands require to be afforested, or where the supply of indispensable articles of forest produce by private enterprise is insufficient or uncertain.

Instead of acquiring State forests the Government may encourage the formation and maintenance of forests by private owners, by assisting them with money at a low rate of interest and by removing through legislative enactments difficulties opposed to good management. If these do not have the desired result, the State may have to proceed to the acquisition of land and afforest it.

4. *General Principles according to which State Forests should be Managed.*

State forests should afford the greatest possible advantage to the community as a whole, and the system of management should be shaped accordingly.

The question in what manner the community derives the greatest possible advantage from its forests, has given rise to prolonged discussions which have by no means terminated. The advantages may be represented by direct and indirect benefits, the former may be represented by cash, quantity of produce, or produce of a certain kind, or generally by the financial results of the industry. All these considerations generally express themselves by the manner of determining the rotation under which State forests should be managed.

There is one party which demands that State forests should be managed according to principles differing from those applicable to private forests; while the financial principle is admitted in the case of private forests, it is maintained that other considerations should determine the management of State forests, such as the production of the greatest volume, the most suitable description of produce, or the highest possible yield irrespective of interest on the invested capital. Another party will admit no difference between private and State forests; it maintains that State forests represent capital which should yield to the nation as a whole the highest possible interest.

In the author's opinion, there should be, in principle, no difference in the management of private, communal or State

forests, but without going so far as the so-called purely finance party. True forest policy may be expressed in such a manner that it is applicable to all forests, whether they belong to private persons, communes, or the State. True forest policy says:—As forests represent capital, their management should, in the first place, be determined by financial considerations, but the management thus indicated should be modified in so far as other considerations may demand; for instance, where certain classes of produce are otherwise not procurable, it may become the duty of the State to produce them where the welfare of the whole is concerned, whether the operation be financially justified or not.

It rests with the proprietor of the forest to decide what other considerations shall be taken into account, over and above those laid down by the general laws of the country. In this respect, the agricultural classes deserve special consideration, but it is a mistake if the State is guided by pseudo-philanthropy. State forests belong to the nation as a whole; by giving excessive privileges to a part of the people the rest of the nation is deprived of its legitimate rights. This fundamental principle has frequently been overlooked, or set aside.

CHAPTER IV.

FORESTS OF COMMUNES, CORPORATIONS, ETC

In its widest sense, a commune means any association which has or holds something in common. In its narrower sense, as here used, by commune is understood a group of persons enjoying the right of a juridical person, especially as regards public matters. Communes may hold joint property, they exercise political functions, levy local taxes, employ their own police, etc. Forests frequently form an important part of the communal property.

Communal forests have been originated in many ways, such as purchase, gift, planting of communal lands, or even through prescription. The Indian forest law provides for the allotment of Government lands to communes to form village forests. Corporation forests have frequently been established by the afforestation of the catchment areas of water-works.

The returns from such forests benefit the members of the commune, either indirectly or directly; the former, if the receipts from the forests go to the communal exchequer and are used to defray the general expenses of the commune; the latter, if the yield goes directly, either in material or cash, to the members of the commune. In the second case, the right of utilization may be attached to the personal membership, or the possession of land or a house.

In many countries, the communal forests amount to a considerable portion of the total forest area (in Switzerland 67 per cent., Hungary 52 per cent., Italy 43 per cent., France 23 per cent., Germany 19 per cent., Austria 18 per cent.

Although communes should have a large measure of liberty in managing their own affairs, as regards their forest property

a certain amount of supervision on the part of the State is frequently indispensable for the following reasons:—

(*a*) The personal interests of the members of the commune for the time being are likely to injure the sustained yield of the forests; especially the poorer members constantly urge more extended utilization than the forests can stand.

(*b*) Communes which are in debt are inclined to meet their liabilities by overworking the forests.

(*c*) The forests of a commune are not always of sufficient extent to secure a competent manager for them at a reasonable outlay.

(*d*) The maintenance of communal forests tends to consolidate and strengthen communal life; hence it is of importance to the State as a whole that communal forests should be maintained.

The manner and extent of State control over communal forests is not in all cases the same. They depend on the constitution of the commune and the degree of political education. Hence in the case of large towns supervision by the State is less frequently necessary than in the case of rural communities.

It is of importance that supervision should not go beyond what is really required. It is a mistake to demand more, than that the forests shall be managed economically and their yield capacity not reduced. As a matter of fact, State supervision differs considerably in various countries: the following are its principal forms:—

1. *General Supervision of the Forests.*

The object of this is to maintain the general productiveness of the communal property; it comprises prohibition of devastation, control over the sale of forests, their conversion into fields or meadows and compulsory reafforestation.

2. *Technical Supervision of Management.*

This is generally arranged so that the working plans, deviations from them, conversion into fields, sales and

extraordinary cuttings require previous sanction by the State authorities, while the administration is otherwise left to the communal authorities.

In some cases, State officials actually prepare the working plans; in others, the communal officials do so and then submit them for sanction. As a general rule, these working plans are prepared on the principle of a sustained yield; this secured, the requirements and wishes of the commune should be fully considered. Anticipations of cuttings, though undesirable on general grounds, may be sanctioned, provided they are compensated by subsequent savings.

In some countries, communes may secure proper protection and administration in their own way by engaging the services of competent officials. In others, the State reserves to itself the right of approving or rejecting the proposed officials, or of examining them before approval; or such persons must pass the examinations laid down for Government forest officers.

3. *Management through Government Officers.*

In various countries the communal forests are managed by Government officers in the same, or a somewhat modified, way as State forests. The system has the advantages that full justice can be done to the objects aimed at, and that the management is likely to be better and frequently also cheaper. Where the forests of a commune are not large enough to occupy a fully competent manager, they are managed together with those of neighbouring communes or with State forests, so as to form one executive charge.

This method of management has yielded excellent results. It is not in accordance with the principle of self-government on the part of communes, and it may in some cases cause a too minute management of communal forests, where a more simple method of management would suffice. At the same time, in all such cases the communal authorities are expected to co-operate, to express their wishes and to appeal against technical decisions which appear to them objectionable.

Where communal forests form part of a mixed charge, the commune contributes towards the pay of the officer in charge, such contribution being generally calculated by area.

The sale or other disposal of the yield is best left to the commune.

4. *Other Matters.*

The sale, purchase, and partition of communal forests are generally subject to sanction by the State.

Forced afforestation is nowadays admissible only in the case of protection forests.

Forests belonging to endowment funds, universities, monasteries, etc., are in some countries treated in the same way as communal forests, in others as private forests.

CHAPTER V.

PRIVATE FORESTS.

1. *Reasons for State Supervision.*

It has been alleged that amongst the general tasks of the State is comprised the duty of seeing that articles necessary for the welfare of the people are forthcoming, and that they are suitably distributed over the country. In the case of forestry, such articles should be produced without occupying more land than is necessary, unless indeed the absolute forest soil is more than is required for the purpose. Wood, it is said, is an important article of consumption which is absolutely necessary.

It is further maintained that measures taken in the above direction for the public welfare do not constitute an illegal interference with private interests, because forests have always been subject to restrictions, so that present owners obtained them burdened with the right of interference.

Thirdly, it is said that by such interference the owner is not deprived of anything to which he is entitled, since the object of interference is to secure the best possible utilization of the forests and to check abuse of the property.

Hence, it is said, State supervision is necessary and desirable because :—

(*a*) The economic means of private persons are not sufficient for regular forest management. It is said, that private persons rarely have the necessary knowledge to introduce and conduct a systematic management ; their properties are frequently too small to secure the services of competent managers ; in other cases they do not possess the necessary funds ; hence private forestry, if uncontrolled, leads to devastation.

Supervision, it is further said, is necessary, because private persons cannot estimate the total requirements of the country, nor arrange the management of the forests accordingly; to do this requires joint action and not action distorted by the personal interests of each individual.

(*b*) Special stress is laid upon the point that private motives are opposed to the true aims and objects of forestry. It is said that the returns of forestry occur so late that he who sows does not reap; hence private owners are inclined to favour their own momentary interests to the disadvantage of future generations by overcutting and thus devastating their forests. The consequence might be overstocking of the market at one time and a wood famine at another.

(*c*) Without State supervision the rights of third persons over private forests might be interfered with.

2. *Reasons against State Supervision.*

The reasons brought forward against State supervision of private forests are somewhat on the following lines:—

(*a*) Private forestry is fully sufficient to meet all reasonable demands made on forests in the public interest. There is no reason to consider forestry as differing in this respect from other branches of industry; the best guaranty for a reasonable management is to be found in the prospect of a corresponding profit. Should an owner not be in the position of managing his forest properly, it would pass into other more competent hands. In short, the supply would be regulated by the demand and prices determined accordingly. The fear of a wood famine is unnecessary, because it would not come suddenly, and the means of communication, substitutes for forest produce and the possibility of reducing the use of it, would meet an exceptional strain in this direction.

(*b*) State supervision is not only unnecessary, but actually mischievous. The State has difficulty, if it is at all able, to decide always on the right measure of interference; it is very difficult to estimate the requirements. State forest officers

are not always capable of determining the most suitable system of management, because the latter is not a fixture, but subject to changes from time to time. As a consequence, supervision is liable to be harsh and unjust. It destroys the desire on the part of private owners to take up forestry. It may lead to serious financial loss by insisting on the maintenance of too large an area of forest, thus actually stimulating extravagance in the use of forest produce. State supervision, if efficient, is necessarily very expensive, otherwise it exists only on paper.

(*c*) Instead of obstructing private forestry in a one-sided manner, while fields are free from such interference, the State should try and stimulate it by removing all obstacles to it which now exist,* by encouraging and facilitating the construction of means of communication, the establishment of forest schools, providing good laws for the protection of forest property, the commutation of forest rights, and advances at rates of interest equal to that at which Government can borrow money.

If, after that, private forestry does not attain the desired standard, the State should acquire so much forest that no endangering of the common welfare is to be feared. Under any circumstances, wherever a fair extent of forests already belongs to the State or communities, private forestry may be released of all State interference.

3. *Manner of Supervising Private Forests.*

The measures provided in forest laws and regulations as regards private forests partly tend towards an increase in the quantity and quality of forest produce, and partly to guard against extravagance in the consumption of such produce. They refer to :—

(*a*) Prohibition to convert forests into fields or meadows, or to use them for other purposes.

* Amongst the most serious impediments to successful private forestry in Britain are the preferential railway rates for foreign timber and the danger from fires lighted by railway engines

(*b*) Compulsory afforestation of certain lands.
(*c*) Prohibition to devastate existing forests.
(*d*) The laying down of rules for the management of existing forests.
(*e*) The taking under State management of private forests.
(*f*) Insisting on proper forest protection.
(*g*) Prohibition of dividing private forests.
(*h*) Prohibition of selling private forests.
(*i*) Regulation of the consumption of forest produce.

4. *Summary.*

The question, whether, or to what extent, the State should exercise a control over private forests from an economic point of view cannot be answered straight off; the answer depends on the circumstances of each case. Under any circumstances, the principle should hold good that the State should only interfere for weighty reasons in the interest of the common welfare. In that respect, all depends on the proportion of the forest area already under State control, such as State and communal forests, and on the general condition of the country.

In Britain, the area of State forests is very small, and there are few communal or corporation forests. And yet, so far no State supervision over private forests has become necessary, owing to the favourable position of the country as regards imports of timber and substitutes for firewood. Indeed, such supervision would be practically impossible. In case of necessity, the State must acquire the forests, or plant up waste land.

In continental countries, matters are somewhat different, because the means of import are less favourable and the quantity of substitutes, especially for firewood, smaller and less favourably distributed. Here the State might be called upon to interfere in the interests of the common welfare. The actual state of affairs differs very considerably. Taking

Germany first, the distribution of forests amongst the three classes of proprietors, is as follows:—

		Percentage of total forest area
State and Crown forests	=	32
Communal forests	=	19
Private forests—		
Under control . . . = 15	=	49
Free . . . . . = 34		
		100

State and communal forests together amount to 51 per cent. of the total forest area, and these are all under State control. Owing to this circumstance, supervision over private forests is hardly justified. As a matter of fact, nearly one-third of the private forests are under State control, bringing the area of controlled forests up to 66 per cent. of the total forest area, while 34 per cent. are free.

Private forests are practically free from control in Prussia, Saxony, Meklenburg, Oldenburg, Anhalt, Altenburg, Schaumburg-Lippe, Gotha, Reuss, j. L. In the other German States, private forests are more or less subject to control.

In Austria, private forests are under control.

In Hungary, private forests are under control.

In France, private forests are under control (more or less).

In Switzerland, private forests are under control.

In Italy, private forests are partly under control.

In Sweden, private forests are partly under control.

In Denmark, private forests are partly under control.

In India, private forests are practically free.

Forests which belong partly to private persons and partly to the State or communes are generally under State control.

The above remarks do not, however, refer to protection forests, which have been dealt with in a previous chapter.

PART III.

FORESTRY IN THE BRITISH EMPIRE.

FORESTRY IN THE BRITISH EMPIRE.

It is proposed to apply the conclusions arrived at in Parts I. and II. to the British Empire, in so far as this is possible at present.

The British Empire extends from the north polar regions to about the 55th degree southern latitude. It consists of the mother country, India, the Dominion of Canada, the African colonies, Australasia and numerous other colonies in all parts of the world. The total area of the Empire and the population cannot yet be given, but they may be estimated as follows:—

Area = 12,000,000 square miles.
Population = 400,000,000.

In this mighty Empire all sorts of conditions are met with. All shades of climate are represented, from eternal ice and snow to tropical heat; the rainfall ranges from absolute aridity to over 500 inches a year; extensive low lands and plains alternate with mountain regions which attain to the greatest elevation on the face of the globe. Many parts of the area are densely populated, while extensive regions contain few inhabitants or none at all. By way of illustration, the following data may be given:—

	Area in square miles	Population. Number.	Density of population per square mile.
United Kingdom .	121,379 ...	41,976,827 ...	346
India	1,766,797 ..	294,360,856 ...	167
Cape of Good Hope ...	276,995 ...	2,433,000 ...	9
Dominion of Canada . .	3,782,553 ...	5,591,564 . .	1·5
Australia	2,972,906 ...	3,776,273 ...	1·3

It is obviously impossible to deal with the forest question of such an Empire in a wholesale fashion; that question must be studied and answered for each country separately. In one respect, however, the Empire may be considered together, namely, as regards the timber requirements of the whole. The statistical records laid before Parliament show the imports and exports of timber to have been approximately as follows during a period of sixteen years:—

NET IMPORTS AND EXPORTS INTO

COUNTRY	ANNUAL AVERAGE 1884–88	
	Net Imports £	Net Exports £
1.—United Kingdom	15,000,000	—
2.—Australasia	1,284,000	—
3.—Africa	72,000	—
4.—West Indies, British Honduras and Guiana	—	207,000
5.—India, Ceylon and Mauritius	—	528,000
6.—Dominion of Canada	—	4,025,000
Total	16,356,000	4,760,000
Net Imports	11,596,000	—
Total Increase	—	—
Average Annual Increase	—	—

Total Increase in the 16 years, £10,809,000.

This table is not quite complete, because some of the smaller colonies have been omitted, as well as the lately acquired territories in Africa. In some cases, certain quantities of timber were included under railway materials, so that their value could not be ascertained. On the whole, however, the table shows clearly that the British Empire, although it is said to possess more extensive forests than any other country, pays every year something like 22½ million pounds sterling to foreign countries for timber, and that the imports during sixteen years have increased by 10⅘ millions of pounds, or on an average by £675,000 annually. Apart from timber, there are considerable imports of other articles, such as wood pulp estimated at about £2,000,000 a year and caoutchouc estimated

at about £6,000,000 annually. Here, then, are broad facts which call for serious consideration. Endeavours to develop more systematic forest management in many parts of the Empire have frequently failed, because the limited funds required for such measures were not forthcoming, or other interests prevailed over the dictates of a sound forest policy, while the enormous sum of money which goes every year out of the Empire was lost sight of.

AND FROM THE BRITISH EMPIRE

Annual Average 1890—94		Annual Average 1895—99		Annual Average 1900—03	
Net Imports £	Net Exports £	Net Imports £	Net Exports £	Net Imports £	Net Exports £
17,595,000	—	22,190,000	—	26,540,000	—
1 233,000	—	483 000	—	568,000	—
237,000	—	522,000	—	737,000	—
62,000	—	25,000	—	—	71,000
—	663,000	—	535,000	—	580,000
—	4,470,000	—	4,835,000	—	4,789.000
19,127,000	5,133,000	23,220,000	5,850,000	27,845,000	5,440,000
13,994,000	—	17,850,000	—	22,405,000	—
2,398,000	—	3,856,000	—	4,555,000	—
436,000	—	771,000	—	1,012,000	—

Average Annual Increase, £675,000.

The above table shows further that the mother country swamps all the colonies and India in respect of imports; of the timber valued at £26,540,000 required annually by the United Kingdom its dependencies could only furnish timber valued at £5,440,000. And yet, the United Kingdom has an enormous area of mountain and heath land amounting to some 15,000,000 acres, less than one-half of which could produce all the ordinary timber which is now imported. It has been said that these lands are required for other purposes, such as grazing, or that they produce more income as shooting grounds than if planted with timber trees, but in many instances there are good reasons to doubt such assertions. Be this, however, as it may, the same argument does not hold good

in the case of most of the colonies, where enormous areas are available fit to produce many times the quantity of timber annually imported into the United Kingdom. And yet, many of them are already themselves importing timber on a considerable scale.

India has to provide an enormous population of 294,000,000 people with timber, firewood and other forest produce; apart from a certain amount of teak and fancy woods, it can probably do little towards an increased export of timber.

The Dominion of Canada has, during the years 1900-1903, exported, on an average, timber valued at £4,789,000 annually. With proper measures of forest conservancy this quantity could not only be maintained, but enormously increased. But from many parts of the Dominion reports come of the rapid diminution of the area under useful timber, which leave no doubt that the exports must seriously decrease as time goes on. This is due to reckless cutting without consideration for the regeneration of the forests and to forest fires. Indeed, the latter is by far the more formidable destructive agency of the two. A timber land explorer reported a few years ago that in one so-called "limit" in Manitoba 150,000,000 feet of white spruce timber had been killed by fire in the course of one season, that the fire not only killed the trees but destroyed a good part of them and consumed the moss and vegetable deposits on the ground down to a depth of one foot. These matters are all the more important, because within a limited space of time the United States of America are likely to require every stick which Canada can spare, thus reducing the imports to Britain very considerably.

Turning now to Australasia it may be confidently asserted that a systematic management of its forests is urgently required. The annual imports of timber considerably exceed the exports. At the same time, only New South Wales has, it appears, extensive coalfields which provide coal for that colony, and from which certain quantities are exported. Under these circumstances it may well be asked, how matters will

stand some years hence when the population has further increased. Not only the population but the number of head of cattle, cultivation, railways and telegraph lines have increased during the last twenty years at the most marvellous rate. The population is nearly double what it was twenty years ago, and the same holds good as regards horses, horned cattle and sheep; the land under cultivation has increased at the rate of about 150 per cent., and yet it represents only about one quarter per cent. of the total area. Although the increase may not go on as fast as in the immediate past, there are good reasons to believe that it will continue for many years to come, though at a somewhat reduced rate. On the whole, there can be no doubt that the demand for forest produce will considerably rise. Complaints have already been made that, in many parts of the country, the material for fencing is no longer available, and this difficulty will increase with every succeeding year.

Next to India, the colony of the Cape of Good Hope has perhaps made the most vigorous effort to establish systematic forest management. And yet, that colony imports a considerable quantity of timber annually.

The information collected during the last few years shows that the newly-acquired territories in Africa will not be able to come to the rescue of the mother country, apart from the import of certain quantities of mahogany and other hardwoods. None of the other colonies are in a position to furnish the timber of daily use in Britain, especially as regards a supply of coniferous woods.

At the same time, it is clear to anyone who approaches the subject with an unbiassed mind that, under existing circumstances, the imports of timber into the Empire will increase rather than decrease as time goes on.

Then comes the important question whether, even if the Empire pays for it, foreign countries will be in a position to furnish the necessary timber for any length of time. Data which throw light on this question show that, although the

several sources of supply may not dry up quite as quickly as some people believe, there are suspicious signs of a prospective falling off in the supply. Under these circumstances, the British Empire as a whole should endeavour to safeguard against a calamity which, if it has once set in, can only be remedied after a considerable lapse of time. Although some of the dependencies have made great progress in this direction, others are as yet in the very beginning, and many of the colonies are still "playing" with the forest question. The reason for this is to be found in the constitutional aversion of the Briton to State interference in the case of anything which partakes of the nature of an industry. Whenever the forest question was taken up, whether in India or in the colonies, the usual cry was that the matter might safely be left to private enterprise; then, when people began to feel uneasy as to the result, feeble attempts were made to interfere by half-hearted measures which had for their object to check the further destruction of the forests and the waste of valuable material, without, however, inconveniencing anybody engaged in the business of destruction. It was only when matters had gone from bad to worse that more energetic steps were taken —in other words that, after all, the State did interfere.

Another product of the forest, india-rubber, has become of the first importance. We import rubber annually valued at six million pounds, and we produce only about £300,000 worth in the Empire. Here, then, is a large field for enterprise, considering that many of the tropical colonies and dependencies are admirably suited for the growth of rubber and gutta-percha plants. A commencement of laying out plantations has been made, but operations must be conducted on a considerably larger scale, if the rubber plants destroyed by reckless tapping are to be replaced.

It has been shown in Parts I. and II. of this volume that State interference is more called for in the case of forestry than in most other industries, and it has been explained in what manner this can be effected. The Government of India

recognised the necessity of determined action many years ago. In many of the colonies the question has been taken up in various degrees. In the mother country the forest question, from the economic point of view, is still in its infancy.

A detailed account of the state of affairs in the several parts of the Empire would doubtless be interesting to the reader, but unfortunately reliable information is not available in the case of many of the colonies; hence only the following can at present be dealt with in some detail: India, South Africa, Australasia, Canada and the United Kingdom. Short remarks referring to some of the smaller colonies will be added.

Of these, India has shown how the forest question should be dealt with, thanks to the initiative of that great statesman, Lord Dalhousie, sometime Governor-General of India, and the able assistants whom he secured for the inauguration of his policy. Of the latter, Sir Dietrich Brandis stands out as the centre figure. He organised the Indian Forest Department and started it on the right lines.

CHAPTER I.

BRITISH POSSESSIONS IN ASIA.

EAST INDIA.

It would be beyond the scope of this work to give here a detailed account of all those points on which the general forest policy of India must depend. A few notes on the physical configuration of the country and its climate are, however, indispensable, before dealing with the forest question itself.

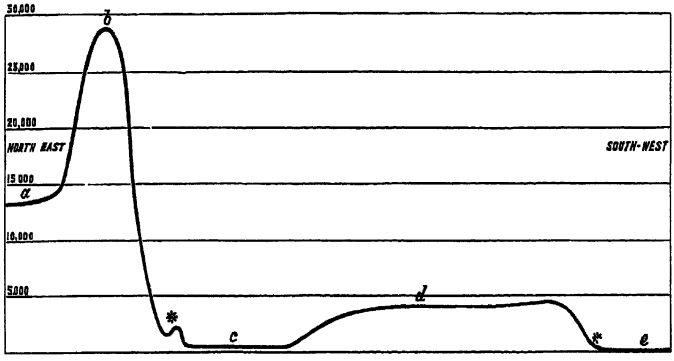
India is a very large country; it extends from the 8th to the 35th degree northern latitude, and from the 67th to the 100th degree eastern longitude. Its length from north to south is 1,920 miles, and its greatest breadth, including Upper Burma, is about the same. On the whole, India proper is of a triangular shape, the Himalayas forming the base on the north, while the southernmost point is Cape Comorin. The triangular peninsula has the Arabian Sea on the west, the Indian Ocean on the south and the Bay of Bengal on the east. Burma lies to the east of the Bay of Bengal. The total area of the Indian Empire is given as 1,766,797 square miles, or about fourteen times that of the United Kingdom, and the population as 294,360,356, or about seven times that of the United Kingdom. An area of 1,087,000 square miles, with 232 million people, is British territory, while the rest is divided amongst native states which are under British suzerainty.

1. *Physical Configuration of the Country.*

The physical configuration of India is very peculiar. Generally speaking, apart from Burma, the country may

be divided into three great sections: the Himalayas, the Indo-Gangetic plain and the Peninsula.

The Himalayan range stands out like a lofty wall on the north, separating India from the high plateau of Thibet. Commencing in the west it runs first in a south-easterly and then in an easterly direction from one end of India to the other; both, on the west and the east other ranges run almost due north and south. The space within these three ranges, immediately to the south of the Himalayas, forms a broad belt of low land, commencing in the west at Kurrachi on the



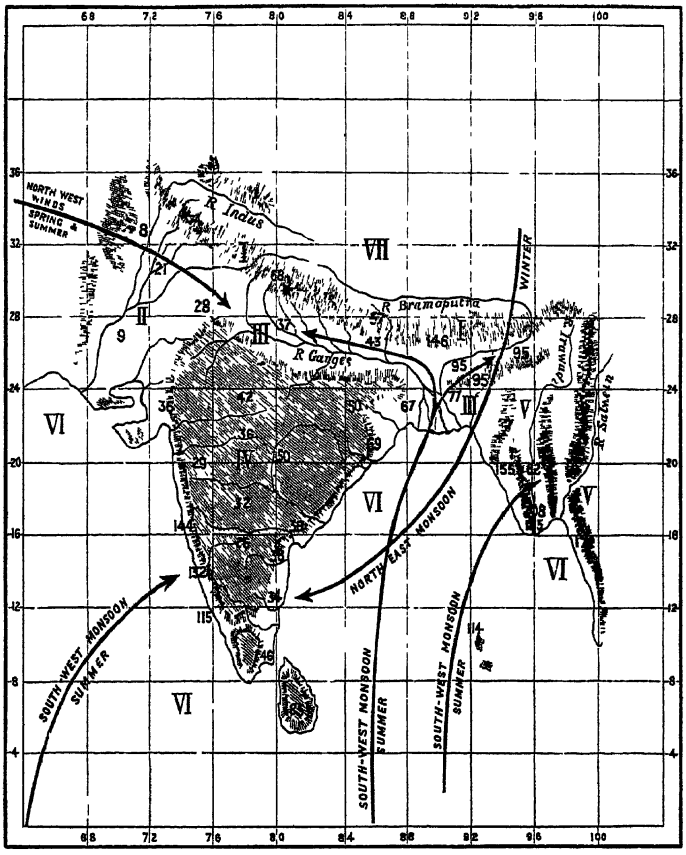
a = Thibetan plateau, mean height about 14,000 feet
b. = Himalayas, maximum height 29,000 feet.
c = Indo-Gangetic plain, height a few hundred feet above the sea
d. = Peninsula, height varying from 2,000 to 8,000 feet.
e. = The sea.
* = Points where the clouds coming from the sea must rise, cool and drop their moisture

Arabian Sea, including Sind, the Punjab plains, the greater part of Rajputana, the United Provinces, Behar and Lower Bengal down to the Sunderbuns beyond Calcutta on the Bay of Bengal. This belt of mostly alluvial land, not more than a few hundred feet above the level of the sea, is the richest part of India.

Proceeding across this belt of low land in a southerly direction stiff escarpments are met, indicating the commencement of the great highland plateau of the Indian Peninsula

which, at elevations varying from 2,000 to 8,000 feet, extends to the southern extremity of India. A section, drawn from the Thibetan plateau in a south-westerly direction until it reaches the Indian Ocean at Travancore, would present the shape given in the sketch on the preceding page, except that the elevations have been greatly exaggerated.

The following sketch-map gives an idea of the extent of each of the regions.



I. Himalayas
II. Indus Plain.
III. Ganges Plain
IV. Peninsula.
V. Burma.
VI. The Sea.
VII. Thibetan Plateau.
8, 9, 21 Mean Annual Rainfall, in inches.

The river system of India next claims attention. It is a curious fact that India receives the drainage of both slopes of the Himalayas. At the back of that mountain chain, three rivers take their rise in close proximity to each other; one, the Sutlej, immediately breaks through the Himalayan chain and descends into the Punjab; the two others run parallel to the Himalayas, the one in a north-westerly and the other in an easterly direction. The former breaks, after some time, through the Himalayas and emerges into the Punjab plain as the River Indus, finding its way, through Sind, into the Arabian Sea. The latter of the two rivers, after running for hundreds of miles to the north of the Himalayas, also breaks through that mountain chain and appears in Upper Assam as the Bramaputra; it then proceeds down the Assam valley, through Lower Bengal and joins the Ganges shortly before reaching the Bay of Bengal.

The southern face of the Himalayas is drained, in its western part, by the five Punjab rivers which join the Indus. East of Simla the Jumna and Ganges, which join at Allahabad, emerge from the hills, and the Ganges takes in a series of streams which drain the southern slopes of the range from the United Provinces to Sikkim. To the east of this point the drainage goes into the Bramaputra. The drainage of the Peninsula is arranged in the following manner:— The Ganges receives the drainage of the northern edge. Next, two rivers, the Narbada and Tapti, run in close proximity in a western direction into the Arabian Sea, but by far the greater portion of the plateau sends its water in an eastern direction into the Bay of Bengal, because the highest part of the Peninsula is close to the sea on the west.

The three principal rivers in Burma are the Irawadi, the Sittang and the Salween. They run from north to south, but the Salween takes also in a large feeder which comes from the south-east.

2. *Climate and Rainfall.*

Owing to the great extent of country included in India and the varying conditions prevailing in the several parts it is impossible to speak of the climate of India; it would be more correct to speak of the "*climates*," of which the following four types may be indicated:—

(1.) The climate of Tropical India.
(2.) ,, of North-Western India.
(3.) ,, of North-Eastern India.
(4.) ,, of the Himalayas.

About one-half of the area of India, comprising the greater part of the Peninsula and Burma, is situated south of the tropic. These are the hottest parts of India, as far as the average of the whole year is concerned; but the highest temperature is found further north. The early arrival of the summer monsoon rains mitigates the summer temperature in tropical India; on the other hand, this region enjoys little or no cool season, except at high elevations.

The second type of climate is found to the north of the tropic in the dry and in some cases almost rainless plain of the north-western corner of India, comprising the area which is traversed by the River Indus. Here, the highest summer temperature is found, due to a greater length of day and a later arrival of the summer monsoon rains than in tropical India; it receives to some extent compensation by four or five cool and even cold months during winter, representing at that time a climate which has been compared with a south Italian winter.

The third type of climate is found in Assam and north-eastern Bengal. Here humidity of the air reigns supreme; although there is a distinct summer and winter, in either case the extremes of temperature are moderated by the effects of a relatively large quantity of moisture in the atmosphere, which produces fogs in winter and interferes in summer with the full effect of the sun's rays on the land.

Finally, the Himalayan mountains present, according to the elevation and position of each locality, a more or less temperate and even Alpine climate with frost, snow, sleet and bitter winds in winter and a moderate heat in summer.

Between these four types any number of intermediate climates are found. However large their number may be, and however much the various climates may differ, they are, apart from elevation, the result of a system of atmospheric changes, which are comparatively simple. The main-springs of the Indian climates are the following:—

(1.) In spring and summer the extensive plains and table lands of India are heated to a much higher degree than the surrounding sea; during winter the air overlying the sea is warmer than that over the land, from which at that season of the year heat freely radiates. The results are sea breezes during summer and land breezes during winter.

(2.) The greater or smaller tendency with which moisture-laden air presses during spring and summer from the south towards India.

(3.) The effect produced by the snowfall of the Himalayas on the movement of dry air currents coming from the north-west and penetrating into the Peninsula.

It will be useful to enter somewhat into the details of these phenomena. In spring, which shall here comprise the months of March, April and May, the highest temperature is found over the centre of the Peninsula (Nagpur, Hyderabad), while it falls as much as 5 to 10 degrees in proceeding towards the sea on the east and west, and about 10 degrees proceeding to the foot of the Himalayas or to the Punjab plain. The effect is that the air over the centre of the Peninsula expands, lifts the higher layers of air, causes them to flow away on all sides and produces a centre of comparatively low pressure. Into this centre presses the heavier atmosphere from the sea, causing the sea breezes so characteristic of the spring months.

These air currents deviate, however, from their original course in consequence of the law that everything moving on

the northern hemisphere presses towards the right. The consequence is that the winds, which hit the Madras coast at this time of the year, are mostly south-easterly breezes, those which hit the southern half of the west coast come from the south-west, while those which hit the land to the north of Bombay become gradually more and more north-westerly winds. These phenomena have the result that Madras and the southern part of Bombay are passed over by moist sea winds which drop a portion of their moisture, producing during this period a rainfall of 3 to 6 inches. The above-mentioned north-westerly breezes, however, descend from the table land of Baluchistan; they are dry and become more so in passing over the heated plains of Sind, Cutch and Kathiawar These are the breezes which are known as the hot winds in the Bombay Presidency, in North-Western and Central India. At times they find their way as far as Bengal and Orissa and far down into the Peninsula.

Up to May the sea winds are light, and they bring only a moderate amount of rain, as the air is then drawn chiefly from the sea immediately surrounding the Peninsula. With the advancing season towards the end of May the winds become stronger and stronger bringing more and more rain, until, in the course of three or four weeks, they have invaded the whole of the west coast of India and the northern and eastern coasts of the Bay of Bengal, an event which is known as the bursting of the monsoon. Now the air comes from more distant equatorial regions, the great reservoir of moist air.

The strength of the monsoon rains differs greatly in different parts of India; it depends on the configuration of the country and the extent to which the sea breezes succeed in overcoming and pushing back the north-westerly air currents. The monsoon currents enter the Bay of Bengal from the south-west and they strike against the coast of Tenasserim in full force, rise and pour out a copious rainfall. This holds good in a varying degree along the coast of Burma,

in Chittagong, Cachar and Assam. Along this line the rain clouds meet with hill ranges at moderate distances from the shore which cause them to rise and drop their moisture, while the Lower Bengal plain receives a somewhat smaller rainfall. After passing through Lower Bengal and on approaching the Himalayan chain that mountain-range opposes itself to the course of the current and divides it into two parts. The larger part continues its north-easterly course and hits full on the Garo, Khasi and Naga hills, producing the highest rainfall in the world (about 500 inches at Cherrapunji), and finally giving a considerable rainfall to the Assam valley. The smaller part of the divided current is diverted towards the north-west and west, plentifully waters the face of the mountains and spreads a certain amount of rain over the plains of the United Provinces.

Lower Burma is plentifully watered, but a part of Upper Burma, on both banks of the Irawadi, receives but a scanty rainfall; the latter increases again on approaching the hills in the northern part of Burma.

On the west coast of the Peninsula the monsoon blows directly athwart the coast line. As the western part of the Peninsula rises very rapidly from the sea to an elevation of up to 8,000 feet at the Ghat range, the clouds are forced to rise, cool and drop an enormous amount of rain. At the same time, the western edge of the peninsular plateau is its highest part, and the clouds or what remains of them, having overcome this, descend again in their north-easterly progress; hence the rainfall diminishes rapidly on the eastern side of the Ghats to about one-sixth of that on the western slopes; this extends over a strip of 100 to 200 miles in breadth and comprises part of the Deccan, the Mysore table land and the Carnatic, areas which are much subject to drought.

Between the north-easterly course of the peninsular monsoon and the westerly course of the wind which, diverted by the Himalayas, moves up the Gangetic plain, lies a broad belt of debatable ground, comprising part of the Central India

States, the Satpura range, the greater part of the Central Provinces, the table land of Chutia Nagpur, Orissa and western Bengal. In this broad belt the rainfall is higher than to the south or north-west of it, chiefly because numerous storms, generated near the coast of Bengal, travel along it from east to west, their passage being accompanied by heavy rain.

The country which lies to the north-west of this belt is, again, under the effect of the western branch of the monsoon; part of this passes through Gujarat, Rajputana, Cutch and Sind towards the Punjab, where it drops varying quantities of rain according to the configuration of the country. On the whole, however, the air current from the west and north-west becomes more and more dry on proceeding north, as it no longer comes from the ocean, but successively from Arabia, Persia, Baluchistan and Afghanistan; hence, the rainfall decreases rapidly to the north of Bombay.

As long as the sea winds are sufficiently strong to keep in check and even force back the north-westerly winds during summer, all is well; but every now and then the reverse is the case, that is to say, the north-west wind forces back the sea winds and proceeds further and further east and south-east into the United Provinces, Behar and even Bengal and Orissa, or it forces its way down into the Peninsula. If it keeps its sway over the sea winds for some period, a failure of the monsoon rains is the consequence, an event which is followed by scarcity or famine. It is believed that the strength of this dry air current from the north-west is intimately connected with the snowfall on the Himalayan ranges; when that fall is heavy the north-west winds are strong and *vice versâ*. Further observations seem, however, necessary to establish the absolute correctness of this view.

The copious watering of the surface of the land, in its turn, reduces the temperature, so that in some parts of the country the rainy season is actually the coolest time of the year. Indeed, this reduction is almost proportionate to the rainfall.

Hence districts which receive little rain, such as Sind, Western Rajputana, parts of the Punjab and also the Carnatic, show the highest temperature during summer. On the other hand, the temperature of Assam is comparatively little affected, because here rain falls copiously even in spring,

In September the monsoon commences to decline, but in Bengal, Assam and Burma the rains last well into October. In the beginning of the latter month the winds in the western part of the Bay of Bengal begin to blow from the north-east, and now for the first time the hitherto scantily watered Carnatic receives a copious rainfall; these rains go on until December, when they gradually move southwards to Ceylon. They are followed by a dry steady north-east wind which gradually extends over the whole Bay of Bengal and is known as the north-east monsoon. An easterly wind takes at that period also possession of the Arabian Sea.

Meanwhile in Northern India the temperature, after a temporary slight rise on the cessation of the rains, has fallen rapidly during November and December, producing a cool air and cloudless skies. About the end of the year, however, clouds begin to gather on mountain peaks, warmer breezes from the south set in, the skies become overcast, followed by a fall of rain or snow on the hills. These winter rains are most frequent in the Punjab and the north-western Himalayas, but occasionally they extend also to Bengal, Rajputana and Central India. They become more frequent in January, February and March. And then a new round of seasons sets in.

It is almost impossible to give in a limited space an adequate idea of the endless differences in the climate and rainfall. By way of illustration, the table on next page is added in which a series of main groups have been formed. More detailed data must be looked for in the Reports of the Meteorological Reporter to the Government of India, from which the table has been compiled.

To illustrate the distribution of the rainfall further, a map

of it is attached. The first of these maps was prepared by Sir Dietrich Brandis in 1872; it has been further elaborated by subsequent observations. The map now given is that contained in Ribbentrops' "Forestry in British India," 1900.

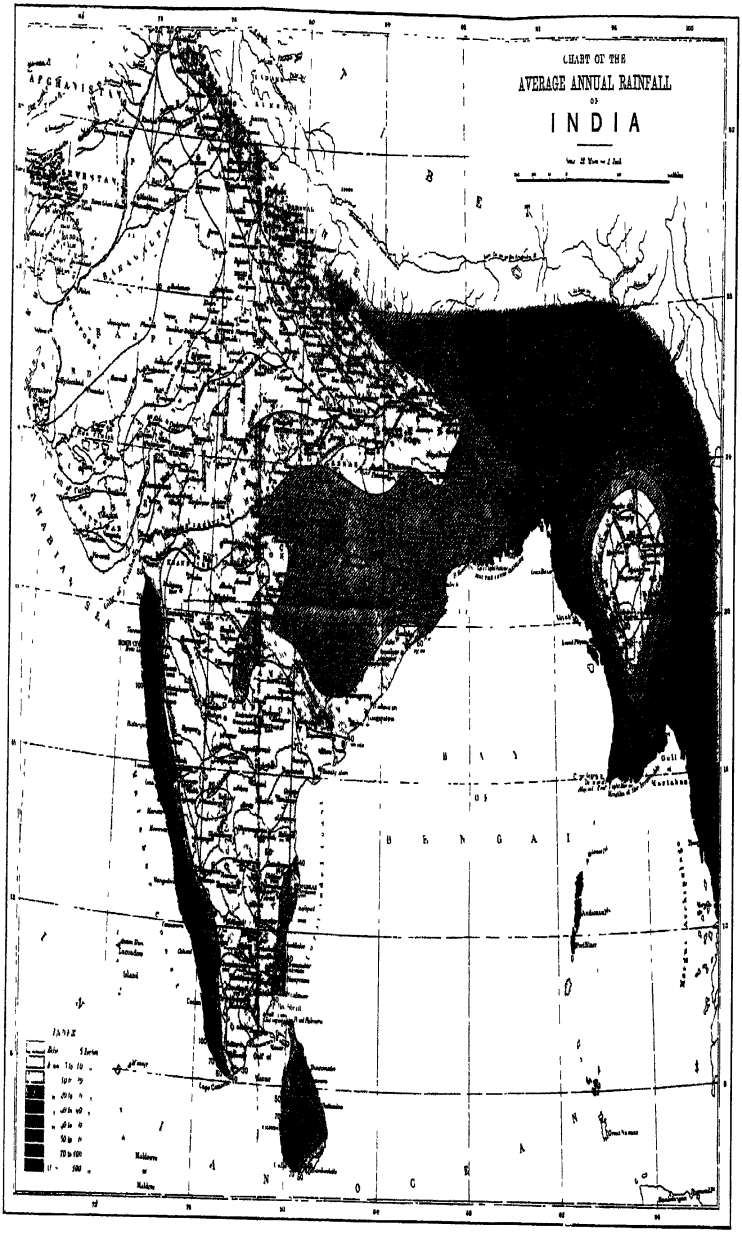
ABSTRACT SHOWING THE CLIMATE AND

SPRING = *March, April, May*
SUMMER = *June, July, August.*

Region	TEMPERATURE, IN DEGREES FAHRENHEIT				
	Spring	Summer	Autumn	Winter	Year
Himalayas	59	71	58	42	58
Indus Plain	83	90	77	60	77
West Gangetic Plain	84	87	77	62	78
East Gangetic Plain and Assam	80	83	78	65	77
Peninsula Northern Edge	82	80	73	62	74
Peninsula West Coast and Ghats	78	74	74	72	75
Peninsula Centre	88	82	77	73	80
Peninsula East Coast	85	85	81	77	82
Lower Burma	83	79	79	73	79
Bay Islands	82	80	80	79	80

3. *Forest Policy of the Government of India.*

In former times, certain forests were carefully protected as game preserves for the pleasure of kings, princes and great nobles. These areas were of small extent when compared with the area of the country. The idea of preserving forests for the supply of timber, fuel and other forest produce, or on account of their indirect effects on climate, rainfall, the regulation of moisture, the stability of the soil on sloping ground, etc., is of modern origin. As will presently be shown, under the policy of the Government of India, as developed during the last fifty years, an area equal to 24 per cent. of the total area of the country has been placed under the management of the Forest Department; the question then arises, whether the



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Government of India has gone too far in this matter, or not far enough, and, if the latter, what further steps should be taken?

It would lead too far to discuss this question here in all its

RAINFALL OF THE DIFFERENT PARTS OF INDIA

AUTUMN = *September, October, November.*
WINTER = *December, January, February*

Region	Mean Annual Vapour Tension, in inches	Mean Annual Relative Humidity, in per cent of Saturation	Rainfall, in Inches				
			Spring	Summer	Autumn	Winter	Year
Himalayas . .	332	73	11	61	16	5	93
Indus Plain .	483	47	2	14	3	2	21
West Gangetic Plain . .	569	62	2	26	8	1	37
East Gangetic Plain and Assam .	748	80	15	43	17	2	77
Peninsula Northern Edge .	477	54	1	31	9	1	42
Peninsula West Coast and Ghats	700	79	6	103	22	1	132
Peninsula Centre	·561	56	3	22	10	1	36
Peninsula East Coast .	738	67	5	12	18	3	38
Lower Burma	·787	77	14	81	29	1	125
Bay Islands . .	·871	81	20	43	39	12	114

details, but the main issues may shortly be touched upon. It is necessary, then, to consider chiefly the following points:—

(*a*) Forests in relation to Climate and Rainfall.

(*b*) The Regulation of Moisture.

(*c*) Forest Produce required by the Country.

a. Forests in Relation to Climate and Rainfall.

The relation between forests and the climate and rainfall of India is of a very peculiar nature. On the one hand, a covering of forest vegetation reduces the temperature of the air and soil, increases the relative humidity and tends to increase precipitation. On the other hand, the exceptionally high temperature prevailing in spring and early summer over the centre of the Indian peninsula is one of the main agencies which bring about the summer monsoon

rains. In other words, extensive afforestation might increase the quantity of locally formed clouds and produce local precipitations, but it might also weaken the force of the south-west monsoon winds and consequently the accompanying rainfall on which the welfare of India depends. It is perhaps difficult to say what the ultimate effect of a general afforestation might be, but it may reasonably be assumed that the effects of forests, however extensive, are not likely to produce a quantity of rain which would make up for any weakening of the south-west monsoon. As a matter of fact, however, more than half the area of Madras, Bombay, the United Provinces and Bengal is under cultivation, and a considerable additional area has been appropriated as grazing grounds, so that not more than one-fourth could remain under forest. That area may be sufficient to moderate the temperature locally, but it is not likely to interfere with the advent of the annual south-west monsoon. The latter must for ever be the main source of moisture in India. Apart from these theoretical speculations, it has yet to be proved whether afforestation in low lands affects the rainfall at all. The extensive observations made of late years in Europe have not yet led to any decided results, and those carried out in India have not extended over a sufficient number of years to permit of any final conclusions.

On the whole, there can be no doubt that, even under the most favourable circumstances, the climate and rainfall of the Indian plains are subject to other influences, compared with which the effect of a limited forest area must always be very small. At the same time, it need scarcely be mentioned how gratefully the shade of forests will be accepted by man and beast in a country as hot as India, and in many cases forests act beneficially as shelter belts to adjoining cultivated lands.

b. Regulation of Moisture.

It will easily be understood that the regulation and proper husbanding of the available moisture must be of great

importance. As far as forest vegetation assists in this, the subject must be considered chiefly from two points of view:—

(1.) In respect of the evaporation of moisture.

(2.) In respect of the mechanical action of forests.

The difference in evaporation from an area exposed to the full effects of the sun and another sheltered by a dense growth of forest vegetation must be much greater in a tropical country like India, than it has been proved to be in a temperate climate. Hence the presence of forests acts highly beneficially wherever the rainfall is limited, or unfavourably distributed over the seasons of the year; in other words, especially in the Indus and West-Gangetic plain and the drier parts of the Peninsula and Upper Burma.

There is, however, a second way in which forest vegetation acts most favourably, namely as a help towards successful irrigation. Of the 220,000,000 acres which are cultivated annually in British India, no less than 30,000,000 acres are artificially watered, either by canals, or from wells, lakes and tanks. Some of the canals are fed with water derived from the enormous snow fields of the Himalayas, and the rest with water which comes from other sources. Accordingly, the irrigated area may be classified as follows:—

Area irrigated from canals . .	13,000,000	acres.
„ „ „ wells . . .	10,000,000	„
„ „ „ other sources .	7,000,000	„
Total . . .	30,000,000	„

Only some 5,000,000 acres, equal to 16 per cent. of the total irrigated area, rely directly on the melted snow of the Himalayas. Of the 10 million acres irrigated by well-water, by far the greater part is situated in the Indo-Gangetic plain. The wells in this plain may be said to tap great reservoirs underlying the plain. Part of this water may come from melted snow, but the greater portion consists, no doubt, of the rain water which has sunk into the ground.

The remaining 15 millions of acres derive their water from the rain which falls on the heated surface of low lands and moderately high hills. The larger the proportion of the catchment areas, whence this irrigation water comes, which is shaded by forest vegetation, the more favourable and sustained will be the supply of water. Here, then, is a mission which forestry in India has to fulfil.

The mechanical action of forest vegetation on sloping ground, also, is not without importance in India. There is sufficient evidence to show what careless or injudicious clearing of forests may do. Anyone who has ever stood on the hills behind Hoshiarpur in the Punjab and looked down upon the plain stretching out towards the south-west, has carried away an impression which he is not likely to forget. In that part the Siwalik range consists of an exceedingly friable rock, looking almost like sand caked together. Formerly, the range was covered with a growth of forest vegetation, but a number of years ago cattle owners settled in it, and under the combined attacks of man, buffaloes, cows, sheep and goats the natural growth disappeared, while the tread of the beasts loosened the soil. The annual monsoon rains, though not heavy, soon commenced a process of erosion and of carrying away the surface soil. Gradually, small and then large ravines and torrents were formed which have torn the hill range into the most fantastic shapes, while the *débris* has been carried into the plains forming fan-shaped accumulations of sand. These, commencing at the places where the torrents emerge from the hills, reach for miles into the plain, and have already covered and rendered sterile extensive areas of formerly fertile fields. Indeed, one of these currents, or drifts of sand, has actually carried away a portion of the town of Hoshiarpur. The evil has by no means reached its maximum extent,* and, if curative measures are not adopted at an early date, the progress of transporting the hill range into the plain will go on until the greater part of the fertile plain stretching

* See Baden Powell's pamphlet

The Hoshiarpur Chos, showing the formation of a torrent by erosion
(From Baden-Powell's pamphlet)

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The Hoshiarpur Chos, showing a fan-shaped accumulation of sand, covering formerly fertile fields in the plain
(From Baden-Powell's pamphlet)

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away from its foot has been rendered sterile. To cure the evil it is necessary to stop grazing, at any rate that of goats and sheep, so as to allow the hills to re-clothe themselves with a covering of plants, shrubs and trees, and to help by artificial sowing and planting wherever required. It is understood that the Government of the Punjab has of late paid attention to the matter and inaugurated measures with the object of preventing further mischief.

Although the case of the Hoshiarpur Chos, as they are called, is the worst of its kind in India, there are other instances which prove that afforestation is essential on hill sides, wherever the rock is friable and liable to be carried away by the continued action of water. It would, however, be a mistake to assume that every hill slope requires to be under forest. Over considerable areas the rock is firm and capable of holding its own without the steadying help of a growth of forest vegetation.

c. Forest Produce required in India.

Although India has an extensive seaboard along which forest produce can be landed, it does not derive so much benefit from this fact as might be assumed at first sight, because it is such a vast country. The distance between the seashore and the places of consumption in the interior of the country amounts frequently to many hundred miles; railways are as yet not as common as they are in England, and forest produce is for the most part bulky; hence only the coast districts would profit by the more ordinary classes of imported forest produce, even if they could be brought in sufficient quantities from other countries. As a matter of fact, only a certain number of railway sleepers and a limited quantity of timber is imported. By far the greater part of India must rely on the timber and fuel produced in the country.

The iron industry of India is at present very limited, so that the bulk of iron and steel is imported; hence their use is much more restricted than in England, timber being, as a

rule, used in their place. Although considerable beds of coal exist in the country, they are very inconveniently situated, so that coal is at present used chiefly for industrial purposes; and certain railway lines even now use wood in the engines, owing to the high price of coal in consequence of the long haulage.

All the teeming millions of India use wood fuel in their domestic firing and, if this is not available, dried cow dung. Their using coal is out of the question for a long period to come even if it were available, because the ordinary Indian cultivator has neither the necessary firing arrangements, nor could he afford to pay for the coal.

For domestic firing, India requires to maintain enormous areas under wood which will be almost doubled, if the annual requirements of timber for construction, boat building, tools, agricultural implements, public works, railways, etc., are added. Judging by the standard which applies to continental countries in Europe it may safely be estimated that India should permanently maintain a forest area at least equal to half an acre per head of population, or, in a round figure. 116,000,000 acres in the British provinces, in order to secure a sufficient quantity of timber and firewood. That area would be equivalent to 17 per cent. of the total area of the British provinces.

Apart from timber and firewood, the Indian forests have to supply a great variety of other, or minor, produce, more particularly grazing and grass. The importance of grass preserves has conspicuously been proved during the famines which occurred during the last fifteen years. In many instances forests must be maintained for their indirect advantages. Considering, further, that the population is increasing, there can be no doubt that not less than 25 per cent. of the total area* should remain under forest.

* Russia has 42 per cent.. Sweden, 35 per cent , Hungary, 35 per cent , Austria proper, 33 per cent , Germany, 26 per cent , Norway, 25 per cent , Italy, 22 per cent , France, 16 per cent Of these, France, Italy and even Germany are importing countries

4. *Development of Forest Conservancy.*

If such evidence as is now available can be relied on, the greater part of India was in former times covered with dense forests. In those days the country was probably more fruitful and the climate less fierce than now. Subsequently, settlers opened out the country along fertile valleys and streams, but the destruction of the forests on a larger scale was done by nomadic tribes which, moving from pasture to pasture, fired alike hills and plains wherever they went. This lasted for many centuries. With the advent of British rule, the destruction of the forests became more rapid than ever. The order of the day then became "extension of cultivation at the cost of the existing forests," a process which was carried on for many years without any enquiry as to the ultimate effects. To this was gradually added an increasing demand for timber and pasture for rapidly multiplying herds of cattle which roamed far and wide over the forests. To crown the edifice, railways then came, and with their extension the forests disappeared with greater rapidity than ever, partly on account of the increased demands for timber and firewood used in construction, and partly on account of the fresh impetus given to cultivation along the lines.

Ultimately, when failures to meet the demands for public works were brought to notice, it was recognised that a grievous mistake had been made in allowing the forests to be recklessly destroyed.

The question of forest conservancy in some parts of the country had already attracted attention in the very beginning of the 19th century, because difficulty had been experienced in providing the necessary timber for the Bombay dockyard and other works. A Government timber agency was established, but again abolished in 1823 in consequence of serious complaints having been made against it. In 1843 Mr. Conolly, Collector in Malabar, arose as a great advocate for the protection of the teak forests in that part of India, and he

started a plantation which is now well known as the Nilambur teak plantation. Dr. Gibson was appointed Conservator of Forests in Bombay in 1847. Lieutenant Michael was in charge of operations in the Anamalais from 1848 until 1855. Dr. Cleghorn commenced forest conservancy in Mysore in 1847, and he was appointed Conservator of Forests in Madras in 1856. These are some of the earlier pioneers of forest conservancy in Southern and Western India. In the meantime, in 1852, Pegu had been annexed, and the question of the Burma teak forests occupied the Government of the time. It was at this juncture that Lord Dalhousie, the great administrator, took up the matter and for the first time laid down a comprehensive forest policy. The steps which he took are indicated in paragraph 82 of his "Minute," dated 28th February, 1856, reviewing his administration in India from 1848 to 1856. One of his last measures in connection with forest administration in 1856 was the appointment of Dr. Brandis (now Sir Dietrich Brandis) to the post of Superintendent of the Pegu forests. This officer, in his endeavour to preserve the fine Burma teak forests, carried on a determined struggle with the mercantile community of the province, whose object was to see the forests thrown open to private enterprise on the plea that the supply of teak was inexhaustible, and with the object of getting the greatest possible profit out of the forests in the shortest possible time. Lord Dalhousie having then left India, victory hung long in the balance, but with the help of Major Phayre (afterwards Sir Arthur Phayre), Dr. Brandis was ultimately victorious, and the greater portion of the Lower Burma teak forests was saved, forests which now yield an average annual net revenue of $2\frac{1}{2}$ million rupees.

In 1862 Dr. Brandis was called to Simla to advise Government on forest conservancy in other parts of India. At the outset he worked in conjunction with Dr. Cleghorn, and in 1864 he was appointed the first Inspector-General of Forests to the Government of India. From the year 1862 until 1883

he laboured steadfastly on the introduction of systematic forest management into the various parts of the Bengal Presidency. He also visited Bombay twice to advise the Government of that Presidency, and he entirely reorganised the Madras Forest Department in 1881–83, after which he retired.

The first duty of the new Department was to ascertain the extent of the remaining forests, and more especially that portion of them which was still the property of the State. As already shown, India is a country of extremes as far as climate and rainfall are concerned. The latter more especially governs the natural distribution of the forests. While Jacobabad, in Sind, has a rainfall of 4 inches a year, Cherrapunji, in the Khasi Hills, can boast of a fall exceeding 500 inches a year. Where rainfall and temperature are favourable the reproductive power of the forests is great; where they are unfavourable reproduction proceeds only at a slow rate. During the long continued struggle between human action and the effort of self-preservation on the part of the forests, the latter succumbed wherever the climatic conditions were unfavourable; hence what remained of forests, when the Indian Forest Department was started, was situated in localities with a heavy rainfall, or where a scanty population had carried on a feeble warfare against the woodlands.

Again, the nature of the rainfall governs the character of the forests. Where the monsoon rains are heavy the country is generally covered with evergreen forests; where the rainfall is less copious the forests are deciduous; under a still smaller rainfall they become sparse and dry, and finally the country ends in desert. Thus, the evergreen forests are found chiefly along the west coast of the Peninsula, in the coast districts of Burma and Chittagong and along the foot and lower slopes of the eastern Himalayas. The deciduous forests occupy the greater part of the Peninsula and of Burma away from the coast; they are the home of the teak,

sal, sandal-wood, red sanders, iron-wood, padouk and other valuable timber trees. Dry forests are found in Rajputana and the Punjab, and they gradually disappear in the deserts of Sind. With rising elevation in the hills, more especially in the Himalayas, the forests become gradually temperate, containing pines, firs and oaks, and then Alpine. The other extreme are the tidal forests found along the greater part of the coast of India and in the deltas of the rivers.

The following list of trees, and other plants, characteristic of the several zones, may be mentioned :—

The Western Wet Zone, over 75 inches rainfall: *Guttiferæ*, *Dipterocarpeæ*, *Meliaceæ*, *Leguminosæ*, *Rubiaceæ*, *Euphorbiaceæ*, *Urticaceæ*, *Laurineæ*, *Eugenia*, *Mangifera*, *Anonaceæ* ; also teak, *Tectona grandis* ; *Caryota urens* and other palms ; ferns and bamboos.

The Eastern Wet Zone, over 75 inches rainfall, extends over a great length ; hence it contains a great variety of trees : Many species of oak ; *Castanopsis* ; *Michelia*, seven species ; *Magnolia*, four species ; *Talauma*, three species ; *Manglietia*, two species ; *Dilleniaceæ* ; *Guttiferæ* ; *Mesua ferrea* ; *Ternstræmiaceæ* ; *Dipterocarpeæ*, very numerous, including *Shorea robusta* ; *Ebenaceæ* ; *Ficus elastica* ; *Casuarina* ; *Tectona grandis* ; *Pinus longifolia*, *Pinus Kasya*, and *Pinus Merkusii*, numerous species of bamboos.

In the Intermediate Zone, 30—75 inches rainfall, to which half of India belongs: *Tectona grandis*, up to 26° north latitude ; *Shorea robusta* ; *Chloroxylon Swietenia*, *Pterocarpus santalinus* ; *Hardwickia binata*, *Albizzias* ; *Xylia dolabriformis* ; *Mimusops indica* ; *Bassia latifolia* ; *Dalbergias* ; *Lagerstræmia parviflora* ; *Anogeissus latifolia* ; *Terminalias* ; *Pterocarpus tuberculatus* (Eng.) ; *Bombax malabaricum* ; *Butea frondosa*, *Acacia Catechu* ; *Cedrela Toona* ; *Schleichera trijuga*, *Buchanania latifolia* ; *Bauhinias* ; *Careya arborea* ; *Stephegyne parviflora* ; *Adina cordifolia* ; *Dendrocalamus strictus* and other bamboos.

In the Northern Dry Zone, 15—30 inches rainfall: *Bombax malabaricum; Butea frondosa; Acacia Catechu; Dendrocalamus strictus; Prosopis spicigera; Grewias; Capparis aphylla; Salvadora; Cordia; Acacias; Anogeissus pendula; Dalbergia Sissoo.*

In the Southern Dry Zone, 15—30 inches rainfall: *Prosopis spicigera; Capparis aphylla, Santalum album; Pterocarpus santalinus; Zizyphus Jujuba; Albizzia amara, Acacia arabica,* and other acacias.

In the Arid Zone, under 15 inches rainfall: *Acacia arabica; Prosopis spicigera; Tamarix dioica* and *gallica; Populus euphratica; Capparis aphylla; Salvadora.*

In the Himalayas: Owing to the great exent of the Himalayas there is a great change of vegetation. Commencing in the north-west we find the region of the junipers; then, in the Punjab hills, are found the pine forests, deodar, *Pinus excelsa; Pinus longifolia; Picea Morinda; Abies Webbiana* (of which *Pindrow* is a variety or sub-species); with several oaks, as *Quercus incana, dilatata* and *semecarpifolia.* Further east, oaks, chestnuts, magnolias, laurels and others prevail, though several conifers are still present.

It is not possible to give an adequate description of the Indian forest vegetation without overstepping the limits of space admissible on the present occasion. While Sind has only some ten species of trees, Burma has several thousand trees and woody shrubs; between these two all intermediate stages are represented. The following short remarks may here be added:—

The three most important Indian trees are the teak, the sal and the deodar. The teak is found in the intermediate zone (30—75 inches) and the wet zone (over 75 inches). It grows in Burma and the Peninsula up to about the 26th degree of northern latitude.

The sal, *Shorea robusta,* is found in a strip running along the foot and outer hills of the Himalayas from the eastern part of the Punjab into Assam and northern Bengal. It

appears again over an extensive area south of the Ganges in Chutia Nagpur, the eastern part of the Central Provinces, Orissa and the northern part of Madras.

Deodar appears in the north-western Himalayas from the Niti Pass into Afghanistan at an elevation of 4,000 to 11,000 feet.

To enable the Forest Department to cope with its duties it was necessary to provide proper protection to the forests. Hence, a forest law was passed in 1865. This law empowered the several local Governments to declare certain areas "State forests" without in any way interfering with the rights of the people. The claims for the latter were, however, on such an excessive scale that real forest conservancy became practically impossible; moreover, they produced a great deal of friction between the civil and forest officers. The result was a new Forest Act, passed in 1878, the main provisions of which were as follows:—

(1.) Power to declare Government lands to be reserved State forests.

(2.) Power to demarcate these, to enquire into, record and settle rights over them, once for all; to commute such rights whenever they prevented the conservation of the areas as forests; and to prevent the springing up of new rights except by Government grant.

(3.) Power to provide for the protection and management of the reserved State forests, of protected and as yet unclassed Government forests.

(4.) Power to protect forest produce in transit.

(5.) Power to provide suitable punishment for the breaking of the forest law.

This Forest Act is permissive throughout, that is to say, it rests with the local Governments to apply it to any particular part of the country, or not.

Subsequently, further acts and regulations on similar lines were passed for Burma, Madras and other parts of the country.

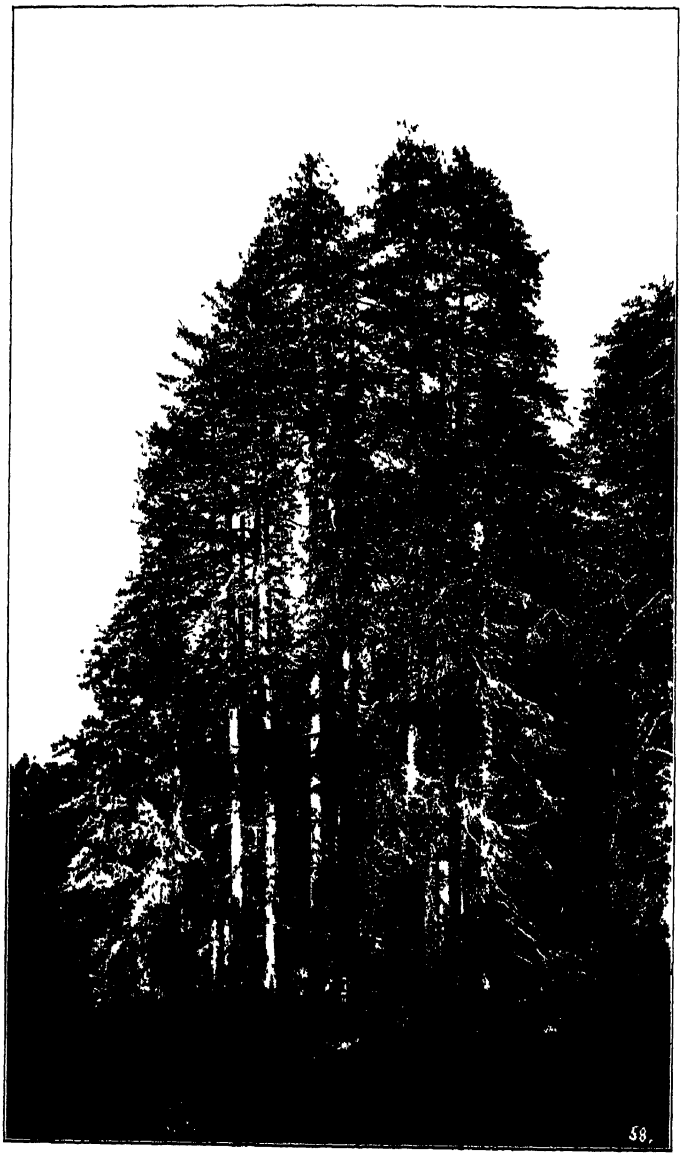
Teak Plantation, two years old, in South Malabar
(From a photograph by A. B. Jackson, I.F.S.)

Teak Plantation, 55 years old, in South Malabar
(From a photograph by A B Jackson, I F S)

Young Sal Tree (*Shorea robusta*) in Kheri
(From a photograph by R C Milward, I F S)

Group of Sal Trees (*Shorea robusta*) in Kheri
(From a photograph by R. C. Milward, I.F.S.)

Young Pole Forest of Deodar, Spruce and Blue Pine (*P excelsa*) in Jaunsar
(From a photograph by R C Milward I F S)



Group of Deodar (*Cedrus Deodara*) in Jaunsar.
(From a photograph by R. C. Milward, I F S)

Stump of a Deodar Tree Jaunsar Girth = 22 feet Length of trunk = 90 feet
This tree gave 460 meter gauge Railway Sleepers
(From a photograph by R C Milward, I F S)

The effect and results of these measures are truly astounding. The following State forests were under the management of the Forest Department in 1904.—

Permanent State forests . .	=	91,567 sq. miles
Protected forests . . .	=	9,865 ,,
Unclassed forests . . .	=	131,269 ,,
Total	=	232,701 sq. miles,

equal to 24 per cent. of the area of the several Provinces

The progress in the different parts of India varies much owing to greater or less difficulties, the amount of land at the disposal of Government and the energy with which the business has been taken up. The following table indicates the present state in the various provinces:—

Provinces	Total Area in Square Miles	Government Forests under the Control of the Forest Department on the 30th June, 1903 In Square Miles				Proportion of Forests to Total Area of Province Per cent
		Reserved	Protected	Unclassed	Total.	
Bengal . .	152,453	6,014	3,567	4,033	13,614	8 9
United Provinces of Agra and Oudh .	105,165	4,048	30	77	4,155	3 9
Punjab . . .	97,223	2,456	4,909	1,914	9,279	9 5
Burma . . .	162,530	20,039	—	103,174	123,213	75 8
Central Provinces and Berar . . .	104,170	22,672	—	4	22,676	21 8
Assam . . .	48,961	3,778	—	18,509	22,287	45 5
Coorg . . .	1,582	410	39	121	570	36 0
North-West Frontier Province . .	13,276	234	—	—	234	1 8
Ajmer . . .	2,646	142	—	6	148	5 6
Baluchistan .	9,403	208	—	—	208	2 2
Andamans .	3,143	156	—	1,795	1,951	62·1
Total Bengal Presidency	700,552	60,157	8,545	129,633	198,335	28 3
Madras ,,	144,389	17,923	—	1,636	19,559	13 5
Bombay ,,	122,883	13,487	1,320	—	14,807	12 0
Grand Total .	967,824	91,567	9,865	131,269	232,701	24 0

Although 24 per cent. of the total area are under the management of the Department, only 9·5 per cent. have as yet

been declared reserved State forests. The process of reservation is still going on, and it may be expected that ultimately at least 15 per cent. of the total area of British India will be declared permanent State forests. There are also extensive areas of private and village forests, but their management is so difficult to control that ultimately the bulk of the produce must come from the State forests, necessitating their careful and systematic management on sound economic lines. To provide for this, Brandis took measures to obtain a competent staff. There were already a number of military officers in the Department who did excellent service; Brandis increased their number to a considerable extent. To meet future requirements, he obtained in 1866 the sanction of the Secretary of State for India (the late Marquess of Salisbury) for the training in forestry of young Englishmen in France and Germany. In 1875 the students were concentrated at Nancy, and in 1885 the forest school at Coopers Hill was established. As that college is about to be closed the forest school has migrated to Oxford, where it now forms the latest branch of the university. In this way, the following forest officers have been trained, up to date:—

In Germany	25
In France	72
Coopers Hill	153
Total	250
At present under training .. .	34
Grand total	284

For the future, the probationers for the Indian forest service will be undergraduates at Oxford, and it is expected that most of them will take their degree in the Honour School of Natural Science before proceeding to India. The theoretical instruction extends over two academic years and the practical over one such year.

So far as to the superior (or Imperial) forest staff. For the training of the executive staff, consisting of natives of India, a fine forest school was established in 1878 at Dehra Dun. Here about 700 native officers have received their education in forestry. A second forest school was started a few years ago in Burma, and the establishment of a third school in Southern India is now under discussion. Thus, an efficient staff for the systematic management of the Indian forests has gradually been built up which stands as follows:—

STAFF OF INDIAN FOREST DEPARTMENT.

Inspector-General of Forests	1	200, Imperial Service.
Conservators	19	
Deputy Conservators ...	117	
Assistant Conservators . .	63	
Extra Deputy Conservators...	5	112, Provincial Service.
Extra Assistant Conservators	107	
Rangers	437	437, Executive Service.
Deputy Rangers and Foresters	1,226	9,759, Protective Service.
Forest Guards	8,533	
Total ..	10,508	

Before leaving this subject an essential point in the organisation must be explained. It has already been stated that in the early days of forest conservancy friction occurred between the civil and forest officers. This has been overcome by making the divisional forest officer the assistant to the Collector of the district. While the Conservator of Forests (or chief forest officer of the province) retains in his hand the direction of all professional matters, his official correspondence with the divisional officer passes through the Collector, who is thus kept informed of what is going on and can interfere whenever he sees fit to do so. Any differences between the Conservator and Collector are adjudicated by the local

Government. This arrangement has worked admirably wherever it has been honestly tried.

Simultaneously with the selection and demarcation of the reserved State forests a proper system of protection and management was commenced and gradually improved. The progress in this respect has been very great. The first and most urgent work was the completion of the forest settlement of the reserved State forests. Out of the total area of reserved and protected forests the settlement has now been completed in the case of 96,466 square miles. In this connection it may be mentioned that up to date no less than 161,846 miles of boundary lines have been actually demarcated.

A special Survey Department was started in 1871 and organised by Captain (now Colonel) F. Bailey, R.E. Up to date 61,855 square miles have been surveyed on a scale of 4 inches to the mile or over.

Protection against fire claimed early attention. Sporadic efforts were made at an early stage, especially in South India, but the first really successful protection of a considerable area, extending over a long period of time, was commenced in the Central Provinces by Colonel Pearson about the year 1860. Now, an area of 35,000 square miles is effectively protected against fire. This area represents 36 per cent. of the area of reserved forests. It is intended to increase the protected area gradually.

Next, working plans were prepared for the forests beginning with those of greatest value. Up to date, such plans have been drawn up for an area of 30,779 square miles, while plans for 10,564 square miles are under preparation.

Although the regeneration of the bulk of the Indian forests must be effected by natural means, still there are extensive areas where planting or sowing must help to restock the forests. Planting operations were commenced some 60 years ago, and up to date the area of plantations amounts to 128,286 acres. About half the area are so-called Toungya teak plantations made in Burma, which will considerabl

The Changa Manga Plantation, showing the nature of the land before planting
Rainfall, under 15 inches In the distance, a sprinkling of *Prosopis spicigera*, *Salvadora* and *Capparis aphylla*

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The Changa Manga Plantation 17 years after planting commenced
(From a photograph by the late Mr D'Arcy)

The Changa Manga Plantation, 17 years after planting commenced
(From a photograph by the late Mr D Airy)

(1)

The Staff of the Changa Manga Plantation

(1) Munshi Fazl Din, Khan Bahadur in charge of the Plantation

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add to the future out-turn of teak from that province. In addition, an area of 1,679 acres has been planted with the rubber plant, *Hevea brazıliensis*, in the Tennasserim circle of Burma.

The above figures do, apparently, not include the well-known Changa Manga plantation in the Punjab, which is now classed as a forest. It comprises an area of 11,000 acres, was started about the year 1868 and yields now a handsome revenue, representing some 8 per cent. on the invested capital. This plantation was made on practically desert land by means of surplus water of the Bari-Doab Canal. The appended three illustrations show the land in its natural condition and 17 years after the planting had been commenced. Similar plantations might, with advantage, be formed in other parts of the Punjab.

5. *Summary.*

History having shown that in India the preservation of an appropriate percentage of the area as forest cannot be left to private enterprise, the Government of that country saw many years ago that forest conservancy must be regarded as a duty to be undertaken by the State. The measures thus inaugurated have led to the establishment of a well organised Department which has charge of some 149,000,000 acres (232,701 square miles) of forests. This represents nearly one-fourth of the total area of British India, and is equal to nearly twice the area of Great Britain and Ireland. Some of these woods had been practically destroyed when the Department took charge of them, while others were as yet in a better condition. Now, everywhere the good effects of protection and proper management are apparent. An economic system of utilizing the produce of the forest has been introduced. The Indian Government forests are throughout treated on the principle of a sustained and increasing yield. The material which has been removed is replaced by natural regeneration, brought about by the properly arranged cutting of

the ripe material, assisted by sowing and planting wherever required.

All this success has been brought about without interfering to any appreciable extent with the acknowledged rights of the people, who, moreover, receive enormous quantities of produce either free of payment or at nominal rates. Indeed it may safely be said that the people in many parts of the country now recognise the importance to themselves of the proper preservation of the yielding power of the forests.

It remains to show what the yield and the financial results of this elaborate system of management are:—

YIELD OF THE INDIAN STATE FORESTS IN 1903—1904.

Timber and Fuel	232,916,345 cubic feet.
Bamboos ...	198,512,073 number.
Minor Produce	4,479,111 Rupees.

Material Removed by Grantees and Right-Holders.

Timber	4,106,000 cubic feet.
Fuel	53,629,919 ,, ,,
Bamboos	13,406,137 number.
Minor Produce given free	value 1,126,222 Rupees.

AVERAGE ANNUAL NET REVENUE OF THE INDIAN STATE FORESTS.

Period.	Amount in Rupees
1864—1867	1,070,000
1867—1872	1,340,000
1872—1877	2,130,000
1877—1882	2,440,000
1882—1887	3,850,000
1887—1892	6,180,000
1892—1897	7,760,000
1897—1902	8,060,000
1902—1903	8,222,000
1903—1904	10,049,754

Value of produce given free in 1903—1904 = 3,069,191 Rs.
Grand total of net result in 1903—1904 = 13,118,945 Rs.

Rapid as the increase of the net revenue has been it is as yet small when compared with the area of the forests, but there seems to be no doubt that the revenue will continue to increase, so as to become one of the important items in the balance sheet of the Indian exchequer.

The exports of forest produce from India during the year 1903—1904 were as follows:—

	Tons.	Value in Rupees
Caoutchouc	90	347,196
Lac	11,781	27,238,970
Sandal, ebony and other ornamental woods	—	1,210,498
Cutch and Gambier	5,652	1,973,711
Myrabolans	61,480	4,210,288
Teak timber	73,913	9,145,605
Cardamoms	128	337,613
Total	—	44,463,881

It is to be hoped that the work so successfully begun may continue to develop further as time goes on. It should, however, never be forgotten that the first duty of future Administrations must be to provide the enormous and ever increasing native population of India with the necessary fuel, grass and grazing and with timber for construction, boat building, tools and agricultural implements. Next, the forests must meet the increasing demands for railways and other public works. Thirdly, the exports should be increased, in so far as the forests can stand it without endangering the home supply. Fourthly, an endeavour must be made to develop the use of the numerous articles of minor produce which these extensive woodlands can yield.

The example set by the Government of India has been followed by several Native States, where forest administration has been introduced on lines similar to those adopted in the British part of India. For this purpose, the Government of India has readily lent the services of British Indian forest

officers, and a number of others have been educated at Dehra Dun for service in the Native States.

But more than this, Indian forest officers have been asked for by, and lent to, many colonies. Amongst these may be mentioned Ceylon, the Straits Settlements, Mauritius, Victoria, New Zealand, South Africa, East Africa, Nigeria, the Soudan, Cyprus, the West Indies and British Honduras. The forests of Siam have been managed by Indian forest officers for quite a number of years. Even the mother country itself has indented on India. The Forest of Dean, the High Meadow Woods and Alice Holt Woods are now managed according to working plans prepared by Indian forest officers, as well as the forests of his Grace the Duke of Bedford, Lord Selborne, Mr. Munro-Ferguson and others. The Professors of forestry at Oxford and Edinburgh Universities are retired Indian forest officers, and so is the Instructor at the School for Working Foresters lately established at the Dean. The assistant for forestry of the Deputy Surveyor of the Dean is a retired Indian forest officer. It is to be hoped that the landed proprietors in this country will soon perceive that they will be acting in their own interest, if they employ, more extensively than in the past, retired Indian forest officers in the management of their woodlands.

It is not too much to say that the development of economic forestry in the British Empire generally has come through India. It is that country which has set the example. There can be no doubt that the development of systematic economic forest management in British India is something to be proud of. An illustrious Indian administrator had no hesitation in stating publicly that it ranks amongst the great achievements realised during the long and glorious reign of Her Most Gracious Majesty the late Queen Victoria and Empress of India.

CEYLON.

The island lies between the parallels of north latitude 5°53′ and 9°51′ immediately to the south of India, from which

it is separated by a channel about 40 miles wide. The area of the island is 25,365 square miles. The population amounted in 1901 to 3,565,954, or 141 to the square mile. It has increased by 29 per cent. between the years 1881 and 1901, which is a considerably higher percentage than that of the United Kingdom. The cultivated area is estimated at about one-sixth of the total area. There is a considerable amount of European enterprise in the shape of the cultivation of coffee, cinchona, tea, cocoa, cocoanuts and rubber. The cultivation of coffee has considerably decreased, on account of disease, and that of tea increased.

The principal topographical feature of the island is a high tableland equidistant from the eastern and western coasts and rising to an elevation of 7,000 feet. This tableland is surrounded on the east, south and west by a range of hills averaging 3,000 to 4,000 feet in height. The rest of the island is mostly low land, especially to the south, east and north of the central plateau.

Ceylon has two wet monsoons, the south-western and north-eastern, the former coming in summer and the latter in late autumn. In consequence, the distribution of the rain is very peculiar, there being a dry, a hill and a moist zone, the rainfall ranging between 33 and 149 inches.

About 1,000 years ago Ceylon appears to have been inhabited by a large and powerful nation. At that time the greater part of the island seems to have been cultivated. Afterwards the population decreased very considerably, and the larger part of the area relapsed into jungle; hence the forests now remaining are a second growth and not genuine primeval forests. At the time of the British occupation in 1796 practically the whole island was covered with forest. Since then, great clearances have been made, and it is difficult to say to what the area of the forests now remaining amounts.

The number of species found in Ceylon is very great. The local consumption of big timber is small, except in Colombo, Galle and Kandy. On the other hand, there has been for

many years an export of ebony (*Diospyros ebenum*), satinwood (*Chloroxylon Swietenia*), halmilla (*Berrya ammonilla*), ironwood (*Mimusops indica*) and a few others. There is also a large export in Palmyra timber (*Borassus flabelliformis*). The exports of other forest produce are small.

The timber trade seems to have become a regular business about the year 1840. Since then, various attempts at forest conservancy and systematic management of the forests have been made, but somehow matters did not run smoothly. The Government of India has lent one forest officer after another to act as Conservator of Forests in Ceylon, but they have all given it up. The fact seems to be that the Ceylon Government has, in reality, never been quite in earnest to carry through an efficient scheme of forest conservancy.

According to the Report for the year 1900, the areas under the management of the Department were as follows :—

	Square Miles.		Percentage of the total area of the Island.
Reserved Forests ...	431	=	1·7 per cent.
Proposed Reserves ...	1,207	=	4·8 ,,
Other Forests	8,929	=	35·2 ,,
Total	10,567	=	42 ,,

It is much to be regretted that better progress has not been made in the formation of permanent State forests. Of plantations, there were 1,763 acres at the end of the year 1900.

The forests do not seem to be protected against fire. The financial results were as follows :—

	Rupees.
Receipts	419,621
Expenditure	335,515
Surplus	84,106
Add value of Free Grants	9,280
Estimated value of Timber on Lands Sold ...	30,000
Total Benefit	123,386

The superior staff seems to consist of one Conservator and eight Assistant Conservators in charge of provincial circles.

The average annual exports of timber during late years amounted to £17,862, the imports to £50,888, or a net import of £33,026. A more vigorous forest policy in the island seems indicated.

The Ceylon climate is well suited for the production of rubber and planting of rubber-yielding trees is being prosecuted. The exports of rubber in 1904 amounted in value to £14,741.

THE STRAITS SETTLEMENTS

The area of the Settlements amounts to 1,526 square miles, the population to 572,249, or 375 to the square mile.

We have an excellent report, dated 1900, on forest operations in these settlements by Mr. H. C. Hill, the lamented late Inspector-General of Forests to the Government of India.

The report shows that an area of 138 square miles, equal to 9 per cent. of the total area of the settlement, had been declared reserved State forests. Mr. Hill's proposals for the future may be summarised as follows :—

(1.) All Crown lands which yield timber and other forest produce should be treated as forests, whether reserved or not.

(2.) A special forest law should be enacted.

(3.) The reserves should be divided into blocks of convenient size.

(4.) Selected reserves should be protected against fire.

(5.) Young gutta-percha woods (*Palaquium* sp.) should be weeded and further plantations made in one or two selected localities.

(6.) All mangrove tracts to be worked on a systematic plan of annual fellings, fixed by area. Other reserves may be closed against cutting of timber for a time, while the most is made of the timber on unreserved Crown lands.

(7.) All minor produce to be utilised as far as demand goes, whether it is found in reserves or outside.

(8.) A trained and experienced officer to be appointed Conservator of Forests with trained Rangers to assist him

These recommendations are being acted on. An Indian forest officer of experience has been appointed Conservator who is gradually getting together a trained staff of assistants, two probationers being at this moment under training at the Oxford Forest School.

The exports of timber are not given in the returns. Those of gutta-percha were valued in 1900 at £1,432,443, and in 1904 at £292,936, indicating a decline in five years of 80 per cent. The average annual exports of rubber during the same five years amounted to a value of £168,512, but, as the imports are not given, it is not possible to state how much of the rubber was produced in the Colony. The cultivation of rubber is vigorously prosecuted. The value of the exported gums came to: *Gum Benjamin* = £47,455; *Copal* = £146,443; *Lac* = £32,571; *Gambier*, net export, £24,050.

On the whole, the Colony offers excellent opportunities for the production of the above-mentioned articles. Of gutta-percha it is the main source, and the Forest Department will, no doubt, take measures to bring up the production to what it was some years ago.

THE FEDERATED MALAY STATES

Estimated area = 26,350 square miles; population 678,595, or 26 to the square mile.

Another report by Mr. Hill, also of 1900, deals with these States. It appears that they are as yet heavily wooded, and it is proposed:—

(1.) That all unalienated lands shall be treated as one property, whether reserved or not;

(2.) that a forest law be enacted providing power to constitute reserved State forests and to reserve certain species of trees in the unreserved forests;

(3.) that in the choice of reserves the following points be taken into consideration:—

(*a*) to protect hill sides against denudation;

(*b*) to preserve mangrove tracts for the supply of firewood;

(*c*) to preserve the gutta-percha producing areas;

(*d*) to preserve all areas producing valuable timber trees;

(4.) that the shifting cultivation of the hill tribes be provided for;

(5.) that the reserves be demarcated and surveyed;

(6.) that rangers be trained for the work;

(7.) that the gutta-percha forests be worked in regular rotation and improved by planting up blanks;

(8.) that natural regeneration may be relied on provided the better kinds of trees are favoured, there being no need for starting plantations at present except of gutta-percha;

(9.) Para rubber (*Hevea brazilhensis*) being largely planted by private persons, there is no need for the State to interfere with them;

(10.) that the Conservator of Forests of the Straits Settlements can supervise the work as part of his duties.

These proposals are now being acted upon. So far, two reserves, containing 31,710 acres, have been established in Perak, while eleven others are under consideration. In Selangor 69,850 acres have been reserved, and other areas are being selected. In Negri and Pahang no reserves have as yet been established.

The forest revenue of these four States in 1900 amounted to 205,454 dollars, and the expenditure to 90,648 dollars.

The Straits Settlements and the Federated States have set an excellent example, by taking forest conservancy in hand before difficulties had arisen, a wise procedure which has, unfortunately, been neglected in many of the large Colonies.

CYPRUS.

A few words about Cyprus may here be added. Area = 3,584 square miles; population, 237,022. The island is,

on the whole, scantily wooded. About 700 square miles are classed as forest, but many parts of it are of a more or less open character. They are situated partly on the southern and partly on the northern range of hills; of these, the former is the more important The most common tree is the pinaster (*Pinus maritima*). There are also found *Pinus laricio*, several species of oak, plane and alder. A considerable area is covered with young cedar, also cypress, juniper, elm and walnut. *Rhus coriaria* (the sumach of commerce), carob and olive flourish. Natural regeneration is slow; seedlings of many kinds spring up, but are believed to die by drought and heat in summer. (Probably cattle and goats do more harm.) There are no funds available for artificial regeneration. The average annual imports of timber are valued at £13,458; the exports of carob at £88,961. A forest officer, assisted by a number of guards, looks after the forests.

TERRITORY OF THE BRITISH NORTH BORNEO COMPANY AND TERRITORY OF SAMARAK

Area of British North Borneo = 31,106 square miles; population = 104,527, or three to the square mile. These territories are rich in timber and other produce of the forest. The net exports in 1904 are given as follows:—

Cutch	value	£27,742
Damar	,,	7,431
Gutta-percha	,,	5,608
India-rubber	,,	21,945
Timber	,,	116,084

Samarak has an area = 41,000 square miles; population = 500,000. Exports of produce of the forests, annual average of the five years 1900 to 1904:—

Gambier	value	£49,667
Gutta-percha	,,	91,274
,, ,, (Jelutong) ...	,,	67,828
India-rubber .. .	,,	53,311
Timber	,,	23,019

CHAPTER II.

AUSTRALASIA.

It is not proposed to deal with the Fiji group and New Guinea. Leaving these out of consideration, the area and population of the remaining seven colonies are given in the subjoined statement:—

AREA AND POPULATION OF AUSTRALASIA

Colony	Area in Square Miles	Population.		Increase of Population in 13 years	
		In 1888	In 1901	Total	In per cent
Queensland . .	668,497	388,000	497,000	109,000	28
New South Wales	310,372	1,086,000	1,359,000	273,000	25
Victoria . .	87,884	1,091,000	1,201,000	110,000	10
South Australia	903,690	318,000	363,000	45,000	14
Western Australia .	975,920	42,000	184,000	142,000	338
Tasmania . .	26,215	146,000	172,000	26,000	18
New Zealand . .	104,471	607,000	773,000	166,000	27
Total . .	3,077,049	3,678,000	4,549,000	871,000	24

This table shows the total area to be about three million square miles with about four and a half million inhabitants, or 1½ per square mile. The population has, however, increased by 24 per cent. during thirteen years, and it is likely to go on increasing.

The mainland of Australia, comprising the first five colonies, lies between the 10th and 39th degree of southern latitude, so that about one-half is within the tropics. Tasmania lies between the 41st and 44th degrees and New Zealand between the 34th and 47th degrees.

The topography of the mainland is peculiar. There are hill ranges running not far from the sea on the east, west and part of the south coast; in the eastern part they rise up to 7,000 feet elevation and in the west to 3,000 feet; on a good portion of the south coast cliffs rise up to 500 feet above the sea. Between these coastal ranges is a tableland consisting chiefly of sandstone and extending over about one and a half million square miles. Numerous comparatively short rivers flow from the coastal ranges into the sea, while some others run first inland and then turn to the sea; the latter are of considerable length, as for instance the Murray River which is 1,300 miles long and drains an area of about half a million square miles before it finds its way into Encounter Bay in South Australia.

The central tableland is heated in summer, and this causes an indraught of moist sea air which brings a good supply of rain to the part of the Continent lying between the coastal ranges and the sea. The central tableland, however, gets rain only at irregular intervals, and its temperature in summer is described to be "like a furnace blast." Sometimes the clouds surmount the coastal ranges, and in these cases cause floods of rain to be poured out upon the central plateau. The meteorological records show an average rainfall at

Spencer Gulf	of	8 inches.
Adelaide	,,	20 ,,
Hobart	,,	22 ,,
Melbourne	,,	26 ,,
Portland	,,	32 ,,
Perth	,,	33 ,,
Newcastle	,,	44 ,,
Sydney	,,	48 ,,
Brisbane	,,	49 ,,
Rockingham Bay	,,	90 ,,

Everywhere the rainfall decreases rapidly on going inland.

The mean annual temperature along the coast districts is given as follows:—

Melbourne	..	57 degrees Fahr.
Sydney	..	63 ,,
Brisbane	..	69 ,,
Adelaide	..	65 ,,
Perth	.	64 ,,

It is much higher in the interior, where the summer temperature is said to rise up to 130 in the shade, or as high as in the north-western part of the Indian Empire.

New Zealand is cooler and moister than Australia proper; long droughts are scarcely known, and the rainfall ranges between 35 and 50 inches.

The true forest region of the mainland is almost entirely coastal. A most luxuriant growth is found on the mountains and hill ranges facing the sea and on tablelands stretching from these towards the shore line. Only where the ranges come close to the coast, as in parts of Western Australia, does the forest belt extend some distance inland beyond the watershed as far as the rainfall suffices. As an instance, the Jarrah and Karri belts on the Darling Hills in Western Australia may be mentioned with an average rainfall of 35 to 40 inches. In most cases, however, only stunted trees and scrub jungle are found beyond the hill ranges ending in stretches of bare land.

The mainland and Tasmania are the home of the eucalypts and wattles. The former reach magnificent dimensions. At one time they were believed to be the tallest trees on the earth, but quite lately it has once more been asserted that they do not reach a greater height than the Sequoias of California. New Zealand, especially in the northern island, is rich in conifers of which the Kauri pine is the finest and most valuable.

The areas under forest, compared with the total areas of the several colonies, have been estimated as follows :—

AREA OF FORESTS IN AUSTRALASIA.

Colony	Total Area, Square Miles	Area of Forests	
		Square Miles	Percentage of Total Area
Queensland	668,497	62,000	9·
New South Wales	310,372	31,000	10·
Victoria .	87,884	18,000	20·
South Australia	903,690	6,000	·7
Western Australia	975,920	32,000	3 3
Tasmania	26,215	17,000	65·
New Zealand	104,471	32,000	31·
Total	3,077,049	198,000	6 4

As regards Western Australia, the area given is that containing timber of commercial value. The colony has, besides, about 120,000 square miles of scrub jungle.

Considering the configuration and climate of Australia, there can be no doubt that the country requires forests to act as shelter against hot winds, to reduce the excessive evaporation of moisture, the violence of floods and the occurrence of erosion. This holds good more especially as regards Victoria and New South Wales. Moreover, woodlands improve the landscape and frequently the healthiness of the country. All the local authorities seem agreed upon these points.

As regards the direct effects of the forests, it may be mentioned that large quantities of wood are required for domestic purposes, fencing, mining operations, railways and other public works. Coal in any great quantities is, apparently, found only in New South Wales.

Although considerable quantities of timber are exported, the imports of conifers are so large that the balance of

trade is against Australasia, as the following table will show:—

ANNUAL NET IMPORTS AND EXPORTS OF AUSTRALASIA.

Average of the Years 1900—1903.

	Imports Value in £	Exports Value in £
New South Wales...	484,000	—
Victoria	605,000	—
South Australia	195,000	—
Queensland	—	20,000
Western Australia	—	493,000
Tasmania	—	21,000
New Zealand	—	184,000
Total	£1,284,000	£718,000

Annual net imports of timber, £566,000.

There is an export of bark for tanning valued at £59,940 a year. The annual exports of Kauri gum from New Zealand are valued at £530,310.

No doubt, the requirements of timber will increase as time goes on. The population has during the last twenty years increased from two and three-quarter millions to four and a half millions; the length of railways from 5,000 to 15,500 miles; the telegraph lines have now a length of 52,000 miles. The land under cultivation was four and a half million acres in 1885; it is now seven million acres. Under these circumstances, efficient forest conservancy seems urgently called for, and it will be interesting to see what has been done in the past.

Queensland.—Under the Land Act of 1897 the Governor in Council can reserve lands and issue regulations regarding licences to cut timber; a minimum girth of tree to be cut is fixed for cedar, kauri and hoop pine; as regards the rest cutting is unrestricted. Out of the forty million acres of

timber lands one and a half million acres have been declared timber reserves. It appears that the staff supposed to look after the forests consists of one inspector and two rangers or bailiffs. The absurdity of such an arrangement has lately been brought prominently before the public by Mr. Philip McMahan, the Director of the Botanic Garden at Brisbane. That officer holds sound views regarding the preservation of the forests, and it is hoped that his advice will be acted on.

New South Wales.—Of the twenty million acres of timber lands six million acres have been withdrawn from settlement, but not in perpetuity, as the withdrawal can be revoked at any time, while the whole area is occupied under pastoral leases. The timber is worked out under a system of royalties or licensing fees. There is no definite forest policy, nor an effective system of control; the cutting of immature trees goes on everywhere; in many parts of the forests no seed trees are kept for regeneration; there is excessive waste in conversion; in fact, the productive power of large tracts has been seriously impaired. The forest branch has been bandied about between the Colonial Secretary, the Minister of Mines, the Minister of Agriculture and the Minister of Lands. The protection of the forests is everywhere subordinate to the policy of settlement. There is apparently no trained forest staff, nor any forest law in force. And yet the value of the forests has recently been estimated at one hundred and fifty million pounds sterling!

South Australia.—The area of forests is under four million acres, situated on the low hills in the neighbourhood of Adelaide and Spencer Gulf; by far the greater part of the Colony is treeless. 217,000 acres of forests have been declared reserves under the forest law of 1882. Of this area only one-fifth contains timber of commercial value, the rest being stocked with stunted trees and scrub. There are, besides, 13,000 acres of plantations stocked chiefly with sugar gums, pines, American ash and other trees. The reserves are under the Minister of Lands, but the Governor can revoke

the reservation, provided he gives notice to Parliament 30 days beforehand. It appears that the forest lands are leased by auction for a term of 21 years. There are a Conservator and six Foresters.

Western Australia has 20,400,000 acres of timber lands and more than four times as much jungle covered with small trees and scrub. The most important timber trees, the areas over which they occur and the quantity of timber standing on them are shown in the subjoined statement:—

COMMERCIAL TIMBER STANDING IN THE WEST-AUSTRALIAN FORESTS.

Species	Area of Forests.	Total Commercial Timber	Per Acre.
	Acres	Loads.	Loads
Jarrah . .	8,000,000	40,000,000	5·
Karri .	1,200,000	15,000,000	12 5
Tuart . .	200,000	300,000	1 5
Others . . .	11,000,000	7,000,000	·6
Total . . .	20,400,000	62,300,000	3

This represents six years' imports of all kinds of timber into the United Kingdom

Jarrah reaches a maximum height of 120 feet, karri 200 feet and tuart 150 feet. There is also a good deal of sandal wood found in Western Australia which is a considerable item of export. Jarrah and karri, with the New Zealand kauri pine, are probably the most important timber trees of Australasia. A considerable trade in them has sprung up, and it seems to be the paramount duty of Western Australia to husband its resources. Trade is all very well, but to squander away State property for the benefit of a limited number of individuals or companies is a mistaken policy. At any rate, measures should be taken, so that a reasonable proportion of the value of the material finds its way into the exchequer. From the data given in the above statement it is evident that the mature material now standing in these forests is anything but inexhaustible. It is, therefore, interesting to

see what Western Australia has done up to date. Some 20 or 25 years ago concessions were granted at nominal rates over 477,000 acres of the best jarrah and karri forests. Under the Consolidated Land Act of 1898 and amendments licences are given at fixed rates; besides, timber leases up to 75,000 acres in each case can be given for 25 years at rates which come to about 1*s.* 6*d.* for each ton of jarrah or karri timber removed. Hence, the share of the value of the timber which finds its way into the public treasury represents only a miserable percentage. On the other hand, there are some State nurseries and small plantations of pines, cedar, poplars and other exotic trees, as well as of wattles and sandal wood. These little plantations will never be able to make up for the exhaustion of the magnificent natural timber forests. Would it not be far more sensible to concentrate the efforts of the State upon the systematic and economic management of the natural forests?

Tasmania has an area of eleven million acres of forests, equal to 65 per cent. of the total area of the island. No parts are permanently reserved, but the reservation of 266,000 acres has been authorised, though they are subject to revocation by proclamation on the part of the Governor. There is no separate forest staff, the management of the woodlands being vested in the Department of Crown Lands. Tasmania has fine eucalyptus timber and a considerable area of wattles. The exports from the island in 1899 were as follows:—

Value of timber	£39,542
Value of wattle bark	£31,042
	£70,584

Since 1898 a royalty on sawn timber has been introduced, the charge being £1 a year per hundred acres as ground rent, 1*s.* per 1,000 superficial feet for eucalyptus timber and 5*s.* for pine and black wood. This works out at about 6*d.* per ton on eucalyptus timber and about 2*s.* 6*d.* on pine and black wood.

New Zealand.—The forest area of New Zealand is given in one place as twenty million acres, equal to 31 per cent. of the total area, and in another place as only twelve million acres. Under an Act of 1885 one and a quarter million acres have been declared reserves, but an amendment of 1888 authorises the withdrawal of denuded or burnt areas for purposes of settlement. In the north the kauri pine is the dominant tree, but according to all accounts it is fast disappearing before timber cutters, settlers and fires. It is a fine tree reaching a maximum height of 160 feet. It yields kauri gum of which in 1899 a quantity of 11,000 tons, worth £608,000, was dug out of the ground and mostly exported. The value of the amount of kauri timber cut annually is given as £400,000. Surely, it is worth while to perpetuate an adequate supply of this valuable tree. There are other coniferous trees of value, as well as the so-called New Zealand teak (*Vitex littoralis*), which is extensively used for railway sleepers. As regards management, there is no special staff, nor is there any definite forest policy. The protection of the forests is everywhere subordinate to the claims of settlements and the interests of timber getters. Some 20 years ago a distinguished Indian forest officer was lent to the New Zealand Government for a year. He drew up an exhaustive and interesting report and gave the Government some sound advice, but, apparently, nothing has come of it.

Victoria.—The area of forests is twelve million acres, or 20 per cent. of the colony. Of these, five and a half million acres have been declared reserves under the Land Act of 1890 and amendments. The alienation of these State forests or timber reserves is forbidden, but denuded areas within the reserves may be sold or occupied for settlement. The forests are managed by the Land Department.

According to the information at the author's disposal there is a Conservator, but he is said to have no real power, nor is there any definite policy in the management of the reserves. The produce is disposed of under the royalty and licence systems. The staff consists of one Conservator, two Inspectors

and twenty-five Foresters, besides two Superintendents in charge of nurseries and plantations. Four State nurseries exist, where a great variety of indigenous and exotic trees are raised. It cannot be said that the results are very satisfactory, for it appears that the expenditure of the Macedon Nursery in 1899, for instance, amounted to £8,388, while the number of plants issued during the year came to 104,000. This works out at £32 for every 1,000 plants, or about 16 to 20 times the amount paid in this country. So far the plantations seem to extend over 1,400 acres. To spend such extravagant sums on little plantations, while the natural forests are, year by year, reduced in yield capacity, can hardly be considered a sound policy. It is certainly not in accordance with the interests of the Colony. The fact is that the Parliamentary influence of the saw-mill industry is so great that it prevents proper measures of forest conservancy being taken. Two Indian forest officers, one of them being the Inspector-General of Forests, have visited the Colony and advised the Government of Victoria.

Summary.—In the year 1897 the Government of Victoria appointed a Commission consisting of eight members. In 1901 the Commission submitted a report dealing fully with the forest question and suggesting a future policy. It proposed the passing of an adequate Forest Act insuring, amongst other items:—

(1.) Independent control of forest reserves.

(2.) Protection of all timber.

(3.) The demarcation of all reserved forests.

(4.) Their protection against fire.

(5.) Encouragement of tree planting in treeless districts.

It next proposed the appointment of a *Forest Conservancy Board* consisting of three members, directly responsible to Parliament, to administer the forests, the Game Act and fisheries. Under it, there should be a Conservator responsible for the reserves and the proper discharge of duties by the staff placed under him. The Commissioners wound up their report with the following words:—

"We feel assured that any intelligent observer, who has

seen the wanton destruction of useful timber throughout the country, the stripping and denuding of watersheds, the erosion of hill slopes and of the banks of streams, and the general disregard of anything but the temporary interests of the present, in utilising or dealing with timber-clad areas, will support us in our contention that the existing laxity of control must speedily come to an end, if the climatic disasters, which have followed like conditions in other countries, are to be prevented from occurring here."

Here, then, is a heavy indictment. What the Commission said about Victoria holds goods as regards other Australian Colonies. No time should be lost in any of them in introducing sensible forest management. The matter seems most urgent in Victoria and New South Wales, so as to save the remainder of the natural forests. Western Australia has commenced following the same reckless system as the above-mentioned two colonies, and it is to be hoped that its Government will lose no time in taking reasonable action. These fine jarrah and karri forests truly deserve a special effort to save them from destruction, and to perpetuate to the State a considerable income for all time to come. Again, it is most depressing to hear of the rapid destruction of the kauri forests of New Zealand. The Government of that Colony had good advice given them many years ago, but practically nothing seems to have been done. Surely, it is great extravagance to destroy a source of revenue like that derivable from these kauri forests. There is yet time to save the situation, because of the total area of Australasia 75 per cent. is as yet unalienated, as the statement on the next page shows.

To be successful, however, it is absolutely necessary to keep the claims of timber getters and of the saw-mill industry within reasonable bounds, and not to allow further settlements to be made in tracts which either contain valuable timber, or which should be kept under forest for their effect upon climate, denudation, or for similar objects. In addition, a competent forest staff must be obtained, and it is a question

for consideration, whether a Commonwealth forest school should not be established in the country—a proposal which has already been made by the above-mentioned Victorian Commission.

AREA OF LAND UNALIENATED IN AUSTRALASIA IN 1902.

	Area in Square Miles.
Queensland	642,000
New South Wales	227,000
Victoria	50,000
South Australia	359,000
Western Australia	960,000
Tasmania...	18,000
New Zealand	67,000
	2,323,000

Even after deducting one and a half million square miles of unproductive land, 800,000 square miles remain unalienated.

CHAPTER III.

BRITISH POSSESSIONS IN AFRICA.

CAPE COLONY.

Of all the colonies the Cape has most successfully grappled with the forest question. It appears that as early as 1819 a Superintendent of Lands and Woods existed at Cape Town. In 1876 a separate Department, called "Forests and Plantations," was constituted. A real start was, however, not made until 1881, when a real Forest Department was organised under Count de Vasselot, a French forest officer. About that time Mr. J. C. Lister, and in 1883 Mr. D. E. Hutchins, joined the Department from India. By 1884, the Department had got to work. Since then several other officers were added, five of whom had been trained at the Coopers Hill Forest School.

For administrative purposes, Cape Colony is divided into four circles, each in charge of a Conservator of Forests. These are assisted by 22 Assistant Conservators, 84 European Foresters and a few native guards in the Native Territories.

As soon as the forests had been demarcated, a Forest Act was found to be necessary, to give effect to the demarcations and to regulate the working of the forests. This was passed in 1888, much on the model of the Madras Forest Act of 1882. The Act was amended in 1902, by adding a provision which laid down that the national forests cannot be alienated, nor any forest rights granted without the previous sanction of both houses of the Legislature.

In this way, the forests which still existed were converted into reserved State forests, their area amounting to 478,867

acres, apart from 27,500 acres in the Transkei which have not yet been reserved; or together 791 square miles. This represents not quite ·3 per cent. of the area of the Colony (276,995 square miles). The population was as follows:—

In 1881	.	721,000 inhabitants.
In 1891	.	1,527,000 „
In 1901	.	2,409,804 „

Hence there was, in 1901, only one-fifth of an acre of forest land for every inhabitant, an area altogether insufficient for the supply of the people and the country generally, especially as the population is rapidly increasing. This is borne out by the trade returns which show that the net imports of timber have already risen to a value of about £450,000 a year, and that they are still rapidly rising.

All these things had to be considered in shaping the forest policy of Cape Colony. An examination of the natural forests showed that of a great number of species only about six were of economic value. These were:—

Podocarpus elongata . .	Two species of Yellow-wood.
„ *Thunbergii* . .	
Ocatea bullata	Stinkwood.
Olea laurifolia	Black Ironwood.
Pteroxylon utile	Sneezewood.
Callitris arborea	The Clanwilliam Cedar.

The two yellow-woods yielded nearly all the building timber used by the early settlers, and it still represents about three-quarters of the commercial timber in the dense indigenous forest, which stretches in a broken belt along the slopes of the coast mountains in Cape Colony and to the north-east of the Transvaal. Stinkwood, black ironwood and sneezewood all yield a hard timber. The Clanwilliam cedar is the most useful of the indigenous timber trees, easy to work, seasons well and is durable. Unfortunately, the cedar woods

have been so destroyed in the past that they now contain no timber of commercial value.

The stock of commercial timber generally in the indigenous forests is small. Moreover, with the exception of the Clanwilliam cedar, natural reproduction is weak and artificial propagation difficult. The indigenous species are also of slow growth. As to the Clanwilliam cedar, it will thrive only under special climatic conditions which are found in certain limited parts of the Colony. Under these circumstances, the authorities decided to establish extensive plantations of exotic species.

Up to date, about 24.000 acres have thus been planted with a variety of species, selected according to the climate of the different parts of the Colony. The number of species is great, and only the more important ones can here be mentioned:—

Pinus pinaster (cluster pine) thrives excellently along the southern coast of the Colony, where the rainfall is sufficient. About 8 tons of seed have been sown annually.

Pinus pinea (stone pine) was introduced by the early settlers, but some 30 years ago it was attacked by a fungoid disease which has almost exterminated the species.

English oak, as well as white and black poplar, have also been successfully introduced. Of eucalypts, a great variety of species have been planted.

Various other species of pine, cypresses, juniper, cedar (*Cedrus deodara*), and Australian wattles are also represented.

During the last 22 years, about £300,000 have been invested in these plantations. Some of them yield already a substantial revenue, and it is estimated that if another 40,000 acres of plantations, costing £500,000, are added, Cape Colony will be supplied with timber altogether derived from its own plantations and natural forests.

In addition to what has been stated, the Government of Cape Colony encourages tree-planting by private proprietors. The Government forest officers help by advice in the form of

pamphlets, lectures and visits to the centres of operations. Large numbers of young trees are sold to the public at low rates. One-half of the cost of tree-planting done by municipalities and county councils (up to £250 in one year) is reimbursed by Government. Similar grants are sometimes made to private tree-planters.

There seems to be no doubt that the authorities at the Cape are working on sound lines, especially as the improvement of the natural forests runs parallel with the establishment of plantations. The only disquieting point is that some of the exotic species introduced on a large scale may some day share the fate of the stone pine and be destroyed by disease; hence somewhat more attention might have been paid to the indigenous species.

NATAL

Natal has an area of 35,371 square miles, and a population of 925,118.

The natural timber forests of Natal, excluding scrub jungle, are said to cover the following areas:—

Natal Proper	40,000	acres.
Zululand	50,000	,,
Total	90,000	,,

or about one-tenth of an acre per head of population.

A considerable portion of the Natal forests contain yellow-wood.

The natives of Natal, forming the greater part of the population, were given extensive forest rights which have produced a deplorable destruction of formerly rich forests.

In 1886 Mr. Fourcade reported on the forests, but neither by him, nor his successor, Herr Schöplin, could anything substantial be done, owing to a vacillating policy on the part of the Government. In 1901, Mr. J. S. Lister, Conservator of Cape Colony, reported once more, and on his

recommendation a Conservator of Forests was appointed in 1902. Since then, the Department of Forestry has been organised on lines similar to those followed in Cape Colony. The Conservator is assisted by thirty forest officials and five apprentices. The natural forests are being carefully looked after, a large distributing nursery has been formed, and plantations started to increase the forest area. The rubber vine (*Landolphia kirkii*) is also being cultivated.

Extensive planting of timber trees is also done on private estates, the area already planted in this way being given at 5,000 acres; the principal species thus planted are eucalypts. Besides, an area of 25,000 acres is stocked with black wattles (*Acacia decurrens*, var. *mollis*) which are said to give a return of about £100,000 a year, derived from the sale of bark and of the poles used for mining props. The average annual imports of timber are valued at £317,140, and the exports of bark at £70,875.

ORANGE RIVER COLONY.

This colony has an area of 50,392 square miles with a population of 387,315. It consists of elevated treeless plains; there are no natural forests left. The country is subject to drought and frost, so that the growing of trees is beset by considerable difficulties. On Mr. Lister's recommendation, in 1903, a Forest Department has been organised, whose duty is to plant and thus to reconstruct forests in the colony. Plantations are being formed near Bloemfontein and on the eastern frontier to begin with. These will, no doubt, be followed by others in various parts of the Colony.

THE TRANSVAAL.

Area = 117,732 square miles; population, 1,354,200.

The indigenous timber forests of the Transvaal are found in the well-watered districts on the eastern frontier. Along the eastern slope of the ranges in these districts an almost unbroken line of yellow-wood forests is found, spreading in

patches over the adjoining plateau. The remainder of the ranges is either treeless or carries quantities of scrub forest. Hence the larger and best part of the Transvaal is practically treeless.

The first Boer settlers planted poplars and willows, followed afterwards by eucalypts and other trees. The area thus planted was small. After the discovery of the Johannesburg goldfields, considerable areas of timber plantations were laid down, chiefly in the vicinity of Johannesburg. The results, it is stated, did not come up to expectations, because the selection of species was not very judicious.

Mr. Hutchins, the Conservator of Forests, Cape Town, visited the Transvaal in 1903 and 1904, and a Conservator of Forests, with a small staff of assistants, was appointed. Since then, good progress has been made with the demarcation of the indigenous forests, and 14,000 acres have already been declared forest reserves. The final area of reserves cannot be given, but it is clear that they will not be able to supply the Transvaal with timber. The imports of timber in 1896 amounted in value to £600,815. During the war they fell considerably, but in 1903 they rose again to £1,022,854. Under these circumstances, the Department set to work establishing nurseries, seed stores and plantations. The latter were started at five different places, so that up to date 682 acres have been planted. It is hoped to plant in future not less than 2,000 acres annually, so as to meet in time the ever-increasing demands, especially for mining timber.

SOUTHERN RHODESIA.

The larger portion of the high veldt of Southern Rhodesia is covered with forest of an open character which, though better than scrub, is far from being good timber forest. The indigenous species are almost all excessively hard, while most of them are not durable.

The first step to be taken as regards forestry in Rhodesia is to determine what areas shall be definitely reserved as forest

and to demarcate and protect them against fire. But much more will have to be done by planting more valuable species. So far, planting in Rhodesia has been almost entirely confined to the Botanic Gardens at Bulawayo and Salisbury and to Matopo Park. Under Mr. Rhodes' will all forest trees suitable for the climate are to be planted in Matopo, an injunction which is being carried out by the Rhodes Trustees. The imports of timber average £45,000 in value annually.

THE WEST COAST OF AFRICA.

The colonies and protectorates here dealt with are:—

	Area in Square Miles	Population.	Per Square Mile
1. Lagos	3,420	41,847	12
2. Gold Coast .	119,260	1,486,433	13
3. Sierra Leone	4,000	76,655	19
4. Gambia	69	13,461	195
5. Southern Nigeria ..	49,704	3,000,000	60
6. Northern Nigeria..	258,000	9,161,700	36

With the exception of the small colony of Gambia, the areas are thinly populated. These countries are of special interest to the forester, because they yield mahogany and rubber. As far as returns are available, the average annual exports of these two articles during the years 1900 to 1904 were as follows:—

VALUE OF EXPORTS IN £ STERLING.

	Mahogany. £.	Rubber. £.
1. Lagos	37,180 ..	22,161
2. Gold Coast .	49,619 ...	215,586
3. Sierra Leone ...	? ...	14,090
4. Gambia	? . .	4,296
5. Southern Nigeria	28,906 .	102,801
6. Northern Nigeria ...	? ...	?

It will be observed that the returns are as yet incomplete. For Sierra Leone, Gambia and Northern Nigeria no exports of timber are given, and for the latter no returns of rubber.

The exports of mahogany from Lagos are rising, those from the Gold Coast fluctuating, and those from Southern Nigeria rapidly rising.

The exports of rubber, on the whole, have rapidly decreased. In the case of Lagos, the exports in 1896 were valued at £347,721; they fell to £9,272 in 1902 and rose again to £22,961 in 1904. In the Gold Coast Colony, they reached their maximum in 1899 with £555,731. Since then, the exports have fluctuated, so that the average of the last five years comes to £215,586. In Sierra Leone, they have fallen during the last five years from £79,196 to £14,090. In Southern Nigeria, they have fluctuated during the last four years between £46,945 and £158,991. Taking all these territories together, the export is now about one-fifth of what it was in 1898. It is reported from all of them that the collection of thelatex has been most wasteful, so that enormous quantities of rubber-yielding trees and climbers have been destroyed. Efforts are now being made to plant especially the Para rubber tree, which, as far as experience goes, seems to promise well and to give larger quantities of latex than the indigenous rubber plants.

Southern Nigeria has now an organised Forest Department, presided over by an Indian forest officer. The minimum size of mahogany trees allowed to be cut has been fixed at twelve feet circumference. Regeneration is said to be good, and a certain amount of planting is done.

EAST AFRICA PROTECTORATE.

Area = 189,838 square miles, with an estimated population of upwards of two millions. A retired Indian forest officer has lately acted as Conservator of Forests; he has organised a small Department, but it is too early to record the results of the measure. The protectorate has of late years exported gum copal valued at £1,000 a year, and rubber valued at £11,000.

UGANDA PROTECTORATE.

Area = 89,400 square miles; population between three and four millions.

The average annual exports of rubber are given as £3,230 in value.

CENTRAL AFRICA PROTECTORATE.

Area = 40,980; population estimated at 924,000.

There is an average annual export of rubber estimated at £7,000 in value.

THE SUDAN.

Soon after the re-conquest of the Sudan the question of the supply of timber and fuel came to the front. The services of Mr. C. E. Muriel, a member of the Indian Forest Department, were obtained, to examine the country and report on its forest resources. He submitted a report in 1901, from which it appears that the Sudan has a far greater variety of trees than might be expected. Of these, the acacias are the most important. Some of them give strong and durable, but hard timber. *Cordia abyssinica* gives a good and durable timber, light enough when dry to float in water. The people cut timber as required, the forests are burnt through annually, and heavy grazing is practised, especially of goats and camels. As long as this unrestricted use continues, no improvement of the timber-yielding forests can be expected. Before any effort can be made to improve forest growth, definite areas must be selected, demarcated as timber reserves and systematically treated. This seems urgent, as already an import of timber has sprung up, reaching a value of some £15,000 to £20,000 a year. Fuel is required, apart from the rural part of the country, for the Government works at Khartoum and Omdurman. To supply that, an area of 100 square miles of fuel reserves is wanted, according to Mr. Muriel. The

necessary areas are available on the Blue and White Niles within a distance of 100 miles from Khartoum.

Of other forest produce, gum is the most important. It is obtained chiefly from hashab (*Acacia Verek*), talha (*Acacia Seyal*), and small quantities from sant (*Acacia arabica*). Hashab yields the best gum, and it comes chiefly from Kordofan. It is said to be also plentiful in Kassala. Protection from fire is absolutely essential in the gum-yielding forests. It is estimated that about 3,000 square miles are stocked with hashab trees. Talha gum is collected chiefly on the Blue Nile, where the tree is said to appear over a very large extent of country.

The Sudan is rich in good fibres, of which that of marak (*Leptadenia Spartium*) is said to be best.

Tans are derived from the fruit pods of *Acacia arabica*, and the bark of the red variety of *Acacia Seyal*. There are other trees which yield tans.

Caoutchouc and gutta-percha are reported to exist. A species of *Ficus* is said to yield rubber, while *Calotropis procera*, gives gutta-percha, which is, however, of small value.

Resin is produced by *Balsamodendron pedunculatum*.

So far Mr. Muriel's report. There seems to be no doubt that a good field for action exists, and the Government has organised a small Forest Department under Mr. Broun, late Conservator of Forests in Ceylon, and originally of the Indian Forest Department. It is too soon to speak of the results.

MAURITIUS.

Area = 705 square miles; population = 371,023, or 526 to the square mile.

Forest conservancy has been aimed at for many years, but somehow matters have not progressed much. At present the areas under the control of the Forest Department amount to 137 square miles, equal to 19 per cent. of the total area. A

distinguished Indian forest officer has lately visited the island and advised the Government regarding the management of the forests. His report appears to be now under consideration. A certain area has been planted, chiefly with exotics. The annual imports of timber average £40,139 in value.

CHAPTER IV.

BRITISH POSSESSIONS IN AMERICA.

THE DOMINION OF CANADA.

THE area of Canada amounts to 3,620,000 square miles, with a population of 5,371,000, or 1½ souls per square mile. In some parts, the population is fairly dense, but over very large areas no people at all are found.

The area of woodlands in the different provinces is given in the subjoined table:—

AREA OF FORESTS IN THE DOMINION OF CANADA.

PROVINCES	Area of Woodlands in Square Miles	Percentage of Woodlands to Total Area.
Prince Edward Island	800	40
Nova Scotia	6,500	31
New Brunswick	14,800	53
Ontario	102,100	46
Quebec	116,500	51
Manitoba	25,600	40
British Columbia	285,600	75
Territories	697,100	29
Total	1,249,000	38

Here, then, is an enormous area. It appears, however, that only about one-third, or 400,000 square miles, can be considered as timber lands, the rest being covered with small growth; still, it is a large area. Nevertheless, Mr. George Johnson, the statistical officer of the Dominion, gave ten

years ago anything but a flourishing account of the state of affairs.

The Canadian forests contain a large number of species, of which the following are the three most important:—

(1) The White Pine (*Pinus Strobus*), found in the south-east of the Dominion.

(2) The Spruce (*Picea alba* and *Picea nigra*), found over extensive areas.

(3) The Douglas Fir or Oregon Pine (*Pseudotsuga Douglasii*), found principally in Columbia and Vancouver Island.

Generally speaking, the bulk of the forests is found in the eastern and western provinces, whereas large prairie tracts are found in the centre of Canada.

The white or Weymouth pine timber used to be the principal item of export; the latter has fallen from 606,000 tons in 1865, to 106,000 in 1893, a reduction of 82 per cent. During the same period the price rose from £1 a ton to £2 16*s*. Measurements have also proved that the average size of logs has fallen 30 per cent. Mr. Johnson concludes that the first-class quality has nearly disappeared, and that the total exhaustion is a matter of only a few years. The causes which he gives are excessive and wasteful cuttings and the fearful destruction by forest fires.

Of spruce, there are yet enormous quantities available; it is practically taking the place of white pine. What with lumbering, the manufacture of wood pulp and forest fires, spruce is likely to share the fate of the white pine as time goes on.

The Douglas fir appears in great abundance and grows to a large size. It is cut by lumbermen for home use and export to the United States and other countries, including the South African mines.

The Canadian forests contain many other species which are of importance. Those of greatest use are enumerated

in the appended statement, showing the material cut in the year 1900, as given in the Census Report of 1901 :—

QUANTITY AND VALUE OF TIMBER AND FIREWOOD REMOVED FROM CANADIAN FORESTS IN 1900.

Class and Kind of Wood.	Quantity in solid cubic feet	Value in £	Value per Cubic Foot, in Pence
Square, Waney, or Flat Timber.			
Ash	416,308	8,916	
Birch	1,203,564	30,256	
Elm	1,354,765	29,428	
Maple	346,433	7,403	
Oak	110,219	3,914	
Pine	2,381,310	91,644	
All other kinds	5,914,314	124,501	
Total	11,726,913	296,062	6·0
Logs for Lumber, etc			
Elm	8,224,100	131,776	
Hickory	165,000	3,941	
Hemlock	20,077,800	225,243	
Oak	1,042,100	30,783	
Pine	153,368,100	3,075,431	
Spruce	104,067,600	1,469,164	
All other kinds	78,751,600	1,022,342	
Total	365,696,300	5,958,680	3·9
Miscellaneous Timber.			
Wood for Pulp	53,442,720	433,702	
Fence Posts	33,357,710	116,136	
Masts and Spars	313,880	5,801	
Piling	2,402,632	47,034	
Railroad Ties	32,607,160	281,383	
Poles for Electric Wires	2,040,888	41,671	
Hop and Hoop Poles	596,074	4,769	
Staves, Bolts, and Headings	1,343,268	29,850	
Total	126,104,332	960,346	1·8
Total of all Timber	503,527,545	7,215,088	3·4
Firewood	707,682,080	2,909,706	1·0
Grand Total of all Wood	1,211,209,625	10,124,794	2·0
Tan Bark		87,902	
Pot and Pearl Ashes		3,843	
		10,216,539	

This table shows that the removals during one year were:—

Timber	... 503,527,545	cubic feet	= 10,070,551 tons
Firewood	707,682,080	,, ,,	= 14,153,641 ,,
		Total ...	24,224,192

valued, including tan bark and pearl ashes, at £10,216,539. Large as this quantity is, Mr. Edwards challenged anyone in the Canadian Parliament to contradict him when he stated that at least ten times the amount was destroyed by forest fires every year. It need hardly be pointed out that even the Canadian forests cannot hold out against such a drain.

The participation of the several provinces in the above output in value seems to have been as follows in 1900:—

	£
British Columbia	526,822
Manitoba	190,010
New Brunswick	599,608
Nova Scotia	681,906
Ontario	4,270,378
Prince Edward Island . . .	57,008
Quebec	3,793,944
Territories	96,853
Total	£10,216,539

The exports from Canada are given in the subjoined table:—

NET EXPORTS OF TIMBER FROM CANADA.

PERIOD	Annual Exports in £			
	To Britain	To the United States	To other Countries	Total
1870—1879	2,627,000	1,481,000	428,000	4,536,000
1880—1889	2,212,000	1,876,000	389,000	4,477,000
1890—1899 .. .	2,493,000	2,427,000	327,000	5,247,000
1900—1904 ..	—	—	—	5,340,294

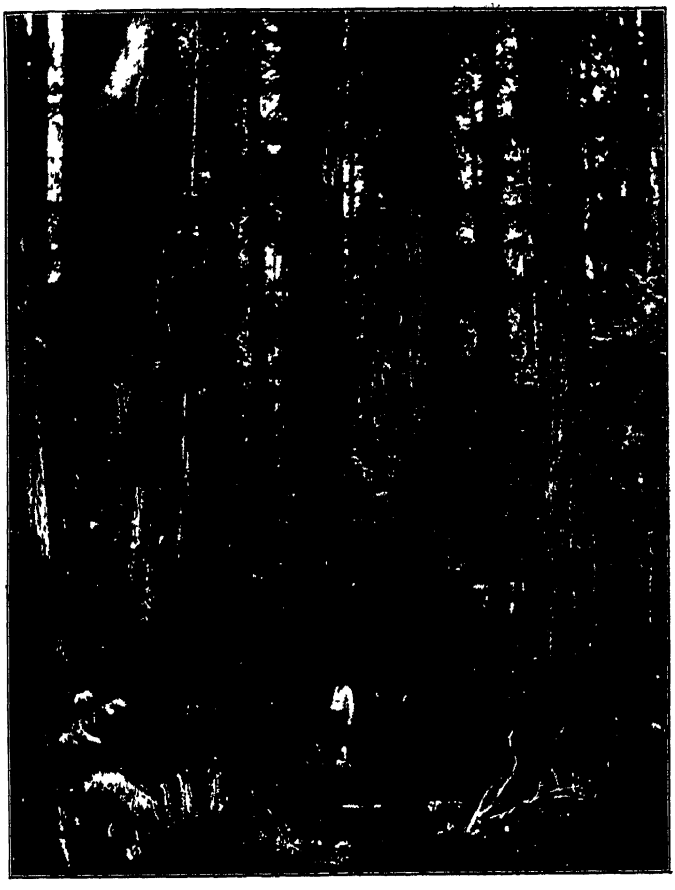
Of the exports, 94 per cent were coniferous timber and 6 per cent hard woods

The data seem to show that during a period of 35 years the exports have increased only by about ½ per cent. a year. They further bring out the fact that the exports to the United Kingdom have fallen off, while those to the United States have greatly increased. As the price per ton has also risen, it may safely be said that the quantity of exports has been practically stationary, if it has not fallen off.

Deducting the exports, which represent about two million tons, it is clear that every inhabitant of Canada consumes annually timber to the amount of about 60 cubic feet, quarter girth measurement, as against 15 cubic feet in Britain. In addition, each person consumes 132 cubic feet of firewood.

Since Mr. Johnson wrote some ten years ago, the forest question has attracted more attention. Measures have been taken to introduce a more economic system of lumbering, and particularly to check fires, but as far as can be judged the results are as yet anything but satisfactory. In order to illustrate this remark, attention is invited to the appended five illustrations, prepared from photographs which were taken about two years ago by Mr. Milward, an Indian forest officer, on his way home from India. They explain themselves.

It is of the utmost importance, not only for Canada but for the Empire generally, that the Canadian forests should, at an early date, be taken under systematic management. The Governments of the several provinces must make up their minds to select and demarcate a sufficient proportion of the area as permanent State forests and bring them under complete control and a rational and systematic management. There are large areas to choose from, so that no difficulties are likely to present themselves in selecting out of the one and a quarter million square miles, say, 150,000 square miles to be reserved, leaving more than one million square miles for unrestricted lumbering and extension of cultivation. The annual revenue from the forests in the immediate past has been about



A Douglas Forest in British Columbia
Before the Lumbermen had commenced work

(From a photograph by R. C. Milward, I.F.S.)

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A Douglas Forest in British Columbia Preparing a Skid-way

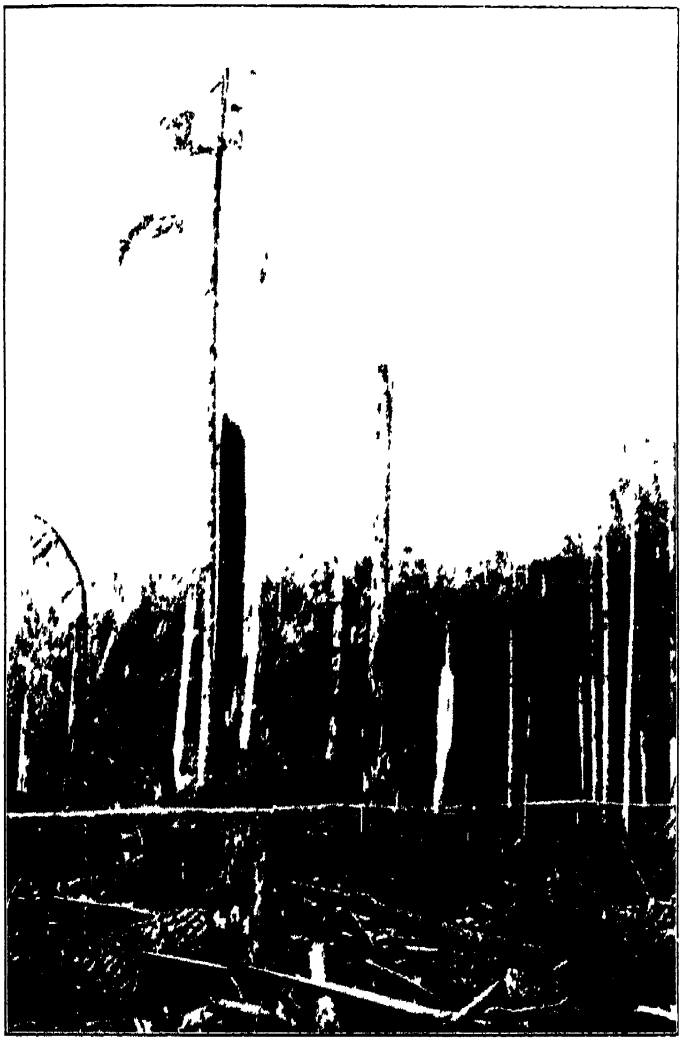
(From a photograph by R C Milward, I F S)

A Douglas Forest in British Columbia The Skid-way completed

(From a photograph by R C Milward, I F S)

A Douglas Forest in British Columbia (Cutting down the Trees

(From a photograph by R C Milward, I F S)



A Douglas Forest in British Columbia
What remains when the lumbermen and fires have done their work

(From a photograph by R. C. Milward, I.F.S.)

£700,000 a year. Why should not half that sum for some years be put aside for the purpose of selecting and establishing these reserves, thereby securing not merely the present but a progressively increasing outturn leading ultimately to a revenue tenfold and more the present amount. There can be no doubt that the supply of coniferous woods in other parts of the world will fall off, and Canada will be looked upon as the only country, whence the diminishing supplies from other countries can be made good. Indeed, it is not too much to say that Canada, if she takes proper measures now before it is too late, will become the source of supply, not only for the British Empire but the whole world, as far as coniferous timber is concerned.

Fortunately, the movement in favour of protecting and husbanding the forests has lately received a new impetus. The Canadian Forestry Association has taken up the matter. The head of the Dominion Forest Department, Mr. Stewart, has started a successful system of protection against fire in the Dominion forests. A Canadian Forestry Convention has been called by Sir Wilfrid Laurier, Premier of the Dominion, to meet in Ottawa on the 10th, 11th, and 12th January, 1906 (that is before this book leaves the press), "to consider the forests of Canada and means for their preservation and reproduction." His Excellency Earl Grey, Governor-General of Canada, has accepted the position of Honorary President of the Convention. The Convention has the support of the leaders of the Dominion in national affairs and assumes a national character. It is to be hoped that wise counsels will prevail, and that at last something substantial will be done to stop the destruction of the immensely valuable forests of Canada.

While the above passed through the Press, the Convention has been held. On the 10th January, Mr. Stewart read a paper, from which the following *resumé* is given :—

"The total area under the control of the Dominion Government is composed as follows:—

	Square Miles.
Prairie land . . .	about 250,000
Barren land in the north .	,, 1,000,000
More or less wooded area .	,, 1,406,201
Total Dominion lands . .	2,656,201
Area of Provincial lands . .	963,618
Grand Total	3,619,819

On a very large portion of the Dominion wooded lands the forest growth is of little value for commercial purposes, so large that only about one-fifth of the 1,406,201 square miles, or 280,000 square miles, can be considered as timber lands of commercial value. Assuming that on this area each acre contains, on an average, 2,000 feet board measure, there are still available 360,000,000,000 feet of mature timber, which at the low rate of royalty to the Government of one dollar per 1,000 feet, would amount to 360,000,000 dollars, or £72,000,000. This represents only the mature timber. [It is clear that the Dominion forests are capable of yielding at least £2,000,000 annually at once; while that revenue can be many-fold increased as time goes on, if the forests are systematically managed and protected against fire.]

The greater part of this timber is growing on land said to be unsuited for agriculture, either from its high altitude or high latitude. Within the forests are rapids and waterfalls more than sufficient to yield the water power required for the conversion of the timber.

Important as the forests are on account of the produce which they yield, they are even more so for the influence which they exercise upon the preservation and regulation of the water supply of the country. By removing the forest growth, roaring torrents will be created to last for a few weeks,

followed by a scarcity of water, with disastrous results for the irrigation works, as in Alberta.

Again, these forests form a barrier against the northern air currents; their destruction would be followed by winters which would be made almost intolerable by the arctic winds sweeping over the denuded land.

To sum up, voices from all quarters call on us to protect our timber areas. Under these circumstances what should be done? Fires are the great enemy of our natural forests. They have caused enormous destruction in the past, and they must be prevented in the future.

Since 1901 a service of fire Rangers has been organised in some of the Dominion lands with the most satisfactory results. That service must be extended until protection is given to all important forest lands.

The forest reserves must be examined so as to ascertain their condition as regards the timber they contain, its quality, the species, their rate of growth, etc., with a view to the gradual introduction of a systematic working on the principle of a sustained yield, and the proper regeneration of the areas where cuttings have been made.

Exploration in advance of settlement will enable us to assign the most suitable areas to agriculture, and to leave the land not suited for it under forest.

Finally, extensive plantations will have to be made in the treeless region. Up to date, some 7,000,000 young trees have been distributed by the Department, and this policy will be vigorously prosecuted."

The following resolutions were passed at the Convention:—

"1. Resolved, that the time is now ripe for a general forest policy for Canada, and that the Federal Government be asked to inaugurate the same.

2. Resolved, that this Convention would urge the importance of the exploration of the public domain in advance of settlement, with the object of determining the character of

the lands so that settlement may be directed to those districts suitable for agriculture, and which give promise of the possibility of the establishment of permanent and prosperous homes for the settlers, and that the lands unsuited for agriculture should be withdrawn from settlement and permanently reserved for the production of timber:

That this Convention approves of the policy of Forest Reserves adopted by the Dominion and Provincial authorities, and favours the extension of such reserves, as may be found practicable from time to time, so as to eventually embrace all lands suited only for the production of timber.

That in the administration of such reserves, this Convention would approve of the policy of having the cutting done under the supervision of properly qualified officers, and that in such operations due provision should be made to ensure the reproduction of the forest.

3. Resolved, that in view of the great saving of timber throughout the Dominion which has been accomplished by the fire ranging staffs organised under Dominion and Provincial authorities, this Convention desires to place on record its approval of the establishment of a fire ranging system for the protection of the forests, and to urge that this system be extended to all forested districts as far as possible, and that, in view of the great interests to be protected, the service under such a system should be made as complete and effective as possible. In this connection this Convention desires to call public attention to the small expenditure made for the protection of the timber resources of the country in proportion to their value when compared with rates of insurance paid on other public property.

4. Resolved that, in view of the many important respects in which the water supply affects the industries of the country, in particular agriculture, irrigation and manufacturing, and the increasing value of the water powers owing to the adoption of electricity for industrial purposes, this Convention would urge that special means should be taken for the preservation of the

forests on watersheds so as to conserve throughout the year the equable and constant flow of the streams dependent thereon.

That in view of the large expenditure made on irrigation works in Southern Alberta, and the intimate relation of the flow of the irrigation streams to the forests of the eastern watershed of the Rocky Mountains, this Convention would specially urge upon the Government of the Dominion the necessity for the protection of the forests on this watershed.

5. Whereas in the older settled districts of Canada conditions are now such that great benefits would be derived by the country as a whole from some systematic movement to re-afforest large tracts of land which at present are lying waste in the agricultural districts; and

Whereas farmers as a rule have no expert knowledge as to the cultivation of trees, and find it almost impossible to obtain nursery stock of forest trees at reasonable prices and of good quality for planting purposes; and

Whereas the farmers of the country are, if properly informed, the right class of people to undertake tree planting in the agricultural districts; and

Whereas the scheme at present in operation in the West, carried on under the Dominion Government, which provides for the free distribution of forest tree seedlings and instruction as to their cultivation, has given satisfactory results:

Therefore resolved that this Convention would urge the Governments, both federal and provincial, to take steps to encourage as far as possible, both by instruction and by giving facilities for obtaining nursery stock suitable for afforestation, a more general interest in tree planting, especially on such lands as are at present unfit for ordinary agricultural purposes, and we would further urge the Dominion Government to make, if possible, further efforts in this direction in the prairie regions, where the results from tree planting are bound to be of inestimable value to the whole country.

6. Resolved, that especially in view of the proposed

construction of a new transcontinental railway and the projection of other lines passing largely through coniferous forests, attention of the Governments of the Dominion and the provinces, and also of the railway companies, be called to the serious danger of loss of valuable timber consequent upon the construction and operation of lines so located, if all possible precautions to prevent the starting of fires are not taken; it be urged that the question be given full and careful consideration.

That to the end sought the railway companies constructing such roads should be required to furnish an efficient equipment and control to prevent fires.

That at such seasons as may be necessary it be required that an effective patrol be established along the afforested line of railway, whether under construction or in actual operation.

And further, that the officers, both of the Governments and the railways, be required to use all possible diligence to prevent the starting or spread of fires through defective equipment or through the carelessness of the operations or negligence of the employees under their control.

7. Whereas it has been the common method in lumbering over a large portion of the timber area of Canada to fell trees by the use of the axe;

And whereas it has been found that trees sawn close to the ground can be felled more cheaply than those cut down with the axe, resulting in a gain of from six to ten per cent. in the scale of the logs, and diminishing the risk of fire caused by chips in felling;

And whereas the felling of logs after the season of snow has resulted in a large loss to the forests of Canada;

Therefore resolved that this Convention recommend to those who are in control of the public lands of Canada the advisability of making such regulations as will carry out the principles of this resolution.

8. Resolved that this Convention is of opinion that the

retention of rough areas under wood and the replanting of areas unsuited for agriculture would be encouraged if some action in the direction of relieving the same from taxation could be put into effect by the Local Government and the Municipalities.

9. Resolved that the Government be and is hereby requested to place forest tree seeds imported for afforestation purposes on the free list "

It is not too much to say that the Dominion of Canada, as well as the whole world, owes a great debt of gratitude to Mr. Stewart for having brought the importance of forest conservancy prominently before the people of Canada. That importance has been repeatedly urged by the author during the last twenty years, and it is a great satisfaction to him that at last something substantial is likely to be done. The resolutions passed at the Convention are in the right direction, and it is hoped, that the Dominion Government, as well as the Governments of the several provinces, will, without delay, take measures to give effect to them.

A general forest law should be passed, to give the necessary legal power for enforcing the sustained preservation and systematic management of the reserved State forests already established or about to be declared. The author has repeatedly pointed out that the Canadian forests are capable of providing the necessary coniferous timber to all countries of the earth which are in want of it, and that Canada will by degrees derive an enormous income from the forests. There is a sufficient area available for the purpose, without in any way whatever interfering with new settlements and extensions of agriculture on the lands most suitable for it.

THE WEST INDIES.

These numerous islands have an area of 12,010 square miles and a population of 1,583,480, making an average of 132 to the square mile. The density of population differs very greatly in the several islands.

There is a certain similarity, from a forest point of view, in all these islands, inasmuch as most of them require the preservation of the forests for the protection and regulation of the water supply and to prevent erosion and denudation. Their forests contain a large number of species of timber trees. Of these, mahogany, cedar and logwood are the most important from a commercial point of view. They also contain other dye-woods, and they yield gums and resins as well as rubber.

It will be impossible to deal with all the islands; some remarks regarding a few will serve to show how forest conservancy stands, and what is needed. Trade returns are available for a few only as far as forest produce is concerned.

JAMAICA.

The island of Jamaica lies between the 17 and 19 degrees of latitude; its greatest length is about 150 miles, while its breadth varies between 20 and 50 miles. The island has an area of 4,207 square miles and a population of 766,546, which makes 182 to the square mile. Of the total area, about 1,250 square miles are said to be still forest or jungle which is equal to 30 per cent. of the total area. This shows that there is rather more than one acre of forest and jungle for every inhabitant.

Formerly, the island had far more forest. The history of the destruction of forest is the history of the cultivation by the negroes. They have now for a long period of time carried on shifting cultivation for the production of yams. Another agency in the process of destruction is the cultivation of ginger. It is estimated that some 30,000 acres of forest land are cleared annually, cultivated for a year or two and abandoned. In other words, about four per cent. of the forest area are cleared annually, and the whole is gone over in about twenty-five years, excepting certain areas which are inconveniently situated. The result is almost complete denudation of the southern slopes of the Blue Mountains, between 2,000 to 4,000 feet elevation.

The forests contain chiefly hardwoods, with a small number of soft woods. Of species and genera we find cedar (*Cedrela odorata*); *Juniperus bermudiana*; *Podocarpus*; *Calophyllum*; *Terminalia*; mahogany (*Swietenia Mahogani*); *Mangifera*; logwood, (*Hæmatoxylon campechianum*); *Paritium* (two species yielding fibre from the bark); *Bambusa vulgaris*; *Eugenia*; cocoanut; lignum vitæ (*Guaiacum officinale*); fustic (*Maclura tinctoria*), and many others. The most important trees are:—

(1) Cedar, very valuable; at present chiefly mature trees are found, showing that the treatment of the forests has prevented reproduction.

(2) Mahogany of very superior quality is said to have been extracted in former times. What remains now, is of inferior quality. It is, however, doubtful whether the quality was really much better in former times. The quantity now exported is very small.

(3) Logwood was introduced in 1715; it took root in the island and spread rapidly on the lower lands. The exports of this important dye-wood have, however, fallen off lately. They were:—

During the period 1888—1893 = 100,989 tons a year.
„ „ „ 1900—1904 = 36,828 „ „

In value the exports fell from £350,003 to £97,688.

(4) Fustic, another dye wood, showed an increase:—

Exports during the period 1888—1893 = 2,269 tons a year
„ „ „ „ 1900—1904 = 4,514 „ „

On the other hand, there is a considerable import of lumber and shooks, so that the balance between exports and imports of timber generally stands as follows:—

Average annual exports during the period 1900—1904:—

	Value £
Logwood	97,688
Fustic	11,387
Spars	5,150
Total exports	114,225

	Value £.
Average annual imports during the same period—	
Lumber £35,278	67,340
Shooks £32,067	
Balance of exports over imports	46,885
Add increase in the export of logwood extract, about	10,000
Grand total	56,885

There can be no doubt that the exports have, during the years 1888 to 1904, fallen off by not less than £200,000 a year.

The Crown lands of Jamaica are stated to comprise an area of 75,000 acres, but further lands have probably reverted to Government since the last return. The 75.000 acres are situated chiefly on the Blue Mountains, in St. Ann and Trelawny; they include the headwaters of the Rio Grandé. The Crown lands are under the Director of Public Works; there is no separate Forest Department.

The authorities of Jamaica were of opinion, some years ago, that forest conservancy was not necessary, as lumber could be imported from America at cheap rates. Since then, the exports of logwood have very considerably fallen off, and it appears that deforestation has commenced to interfere with the water supply in the eastern districts; moreover, forests are necessary to prevent, or at any rate reduce, a torrential flow of the rivers and to protect the low lands. Under any circumstances, the forests on the main ridge should be preserved. Hence, the following measures seem indicated:—

(1) Reservation of the highlands on the Blue Mountains and elsewhere.

(2) Demarcation and survey of the reserves; their protection against fire, theft, alienation and trespass.

BARBADOS

This island has an area of 166 square miles and a population of 195,588, which makes 1,178 to the square mile. The island has a line of hills running from north to south, rising to 1,145 feet above the sea; this hill range is intersected by ravines.

Owing to the great density of population about 100,000 acres, out of a total of 106,000, are used for the cultivation of sugar cane and other crops; hence only a small portion of the island can be classed as forest. What remains of the woods, contains mahogany, cedar, lignum vitæ and other trees. Practically, all timber for use is now imported. During the five years 1900 to 1904 the mean annual imports were valued at :—

Lumber	£25,930
Staves and shooks . . .	£27,986
Total	£53,916

There is little room for forest conservancy, since nearly the whole of the land is required for cultivation.

TRINIDAD

The island has an area of 1,754 square miles and a population of 255,148, equal to 145 to the square mile.

It is stated that of the total area about two-thirds are cultivable, while the other third consists chiefly of swampy ground, rocky and useless land. About 454,000 acres are in the hands of private proprietors. Of the Crown lands, 346,000 acres are classed as cultivable, 223,000 acres are poor land and the rest swamps and waste.

There are three ranges of hills in the island. The chief objects of reserving the forest lands are (1) to protect the sources of the water supply, and (2) the protection of valuable timber. The reserves, or proposed reserves, are mostly situated in the three hill ranges, but some of the areas are on low and cultivable land, as they are required to supply fuel to towns and villages. They may be classified as follows :—

	Square miles
Reserves for the protection of the water supply	252
Reserves for the supply of fuel . . .	80
Reserves forming a wind break on the east coast	11
Total	293

This area is equal to 17 per cent. of the total area. Most of the accessible areas are now poor in mature timber. The forests contain logwood, cedar, fustic, bulletwood (*Mimusops globosa*), mahogany and numerous other species.

An Indian forest officer has now charge of the forests.

The imports of timber during the five years 1900 to 1904 amounted, on an average, to a value of £59.000 a year.

TOBAGO

The island is situated close to Trinidad; it has an area of 114 square miles and a population of 18,751, or 165 to the square mile. The Crown lands occupy about 20 square miles, or 18 per cent. of the total area. The forest question should be dealt with in the same way as in the case of Trinidad. The forest officer mentioned above deals with both Trinidad and Tobago.

ST. LUCIA.

The island has an area of 233 square miles and a population of 49,883, or 214 to the square mile. The forests are estimated to cover about 80 square miles, or about one-third of the total area. They are situated in the centre of the island. Their composition is similar to that of the adjoining colonies. The chief feature is, however, the general appearance of balata (*Mimusops*), and other *Sapotaceæ* and *Laurineæ*, which yield valuable timber. The local demand is as yet small. The streams are mostly of a torrential character; hence denudation is active. It follows that the forests in the hills should be preserved. The lands in question are mostly Crown lands. The forests yield, besides timber, numerous articles of other forest produce, such as fibres, gums and gum resins.

BRITISH HONDURAS

This colony has an area of 7,562 square miles and a population of 37,479, or about five to the square mile. Of the total area only about 90 square miles are under cultivation, all the rest being forest and jungle. These contain mahogany and logwood.

The average annual exports, as far as the data are available, show the following items:—

	Tons	Value £.
Timber, chiefly mahogany	16,000	140,000
Logwood	16,000	123,000
Total	32,000	263,000

These exports represent some 90 to 95 per cent. of the total exports of the colony; hence it is of paramount importance to secure a continuance of this valuable item of export. Rubber of the average annual value of £2,637 was also exported.

In 1885, Mr. E. Hooper, of the Indian Forest Service, was deputed to British Honduras to report on the forests. He states the following:—

"It is a prevailing belief in the colony that the supply of mahogany is not being reduced. No doubt, there is a large amount still standing, but it is so far from the seaboard that it is, under existing conditions of transport, practically valueless. Large trees are now generally found only far up the rivers, while the accessible forests yield chiefly small timber down to ten inches square. All this indicates that the supply of good sized mahogany will fall off, and it is questionable whether the export of it will continue to be an important factor in the progress of the colony. Certain rules have been passed to prevent the cutting of undersized trees (15 inches and under), but it appeared that great laxity prevailed in checking the cutting of undersized mahogany."

So far Mr. Hooper. Unfortunately no information is available to show, whether, or to what extent, matters have improved since Mr. Hooper's visit. It may, however, be said that, if ever a case was made out for the preservation and careful management of the forests of any colony, it is for those of British Honduras. To allow matters to go on, as at the time of Mr. Hooper's visit, would mean the destruction of the bulk of the exports of the colony. In the author's

opinion, a competent forest officer should be appointed without delay, to organise a small Forest Department and to introduce the measures which are necessary to perpetuate the supply of mahogany and other valuable timbers.

BRITISH GUIANA.

The Colony has an area of 109,000 square miles, and a population of 293,958, or three to the square mile. By far the greater part of the country is covered with forest containing mostly hardwoods. There is no Forest Department.

During the years 1900 to 1904, the average annual exports of timber were valued at £22,574. On the other hand, the average imports of lumber were valued at £30,034. The average export of rubber during the five years 1900 to 1904 amounted to 524,496 lbs. valued at £36,416.

Considering the large stock of valuable hardwoods in the extensive forests of the colony, it seems worth while to consider the advisability of stimulating the export and perhaps establishing a forestry branch of the administration. This seems all the more desirable, as the average annual exports of balata gum have of late years rapidly risen. Without speedy protection, the export of rubber is likely to decrease again as rapidly as it has increased.

CHAPTER V.

FORESTRY IN THE UNITED KINGDOM.

Forestry has been carried on in the United Kingdom for many centuries. The main objects, until quite recently, were the chase, shooting and landscape beauty. The economic aspect came more into the foreground, since rents went down and proprietors had to pay more attention to the financial aspect of the industry based upon the land. In bringing about this change, the example of systematic forest management in India has had a powerful influence. It was recognised that, if systematic, economic forestry were to become an enduring thing in India and in the colonies, it would be necessary to make it so in the mother country. When forestry in Britain has once become an essential part of the industry based upon the soil, those who go out to govern the British possessions beyond the seas will be duly impressed by its importance. They will bring to their spheres of action a sympathetic understanding of the business, which will go a long way to prevent any oscillating policy, that otherwise might threaten to interfere with the progress of forest management. Continuity of policy will then become the order of the day, without which no industry can flourish whatever its name or nature may be; and least of all forestry, the produce of which frequently requires a century and more to mature.

Thus it was in the interests of India that the author of this book first took up the subject of British forestry, and it has occupied him ever since he returned from India in 1885. He travelled over the greater part of England, Scotland and Ireland and soon became aware of the great importance to

this country of extended afforestation and improved management of the existing woods. Already in January, 1886, he submitted to the Earl of Carnarvon, then Viceroy of Ireland, at his Lordship's invitation, a pamphlet entitled "Afforestation in Great Britain and Ireland." Before that pamphlet had left the press a change of Government took place, and the pamphlet was, it is presumed, shelved.* However, he went on and at various periods published, not only a Manual of Forestry but further articles, and he read several papers on the subject. Of the latter, attention may specially be drawn to two: (1) "The Timber Supply of the British Empire," read at the Imperial Institute in March, 1897; and (2) "The Outlook of the World's Timber Supply," read before the Society of Arts in March, 1901. During the last seven years he had the pleasure of advising several landed proprietors regarding the management of their woods, for whom he drew up management schemes, or working plans as foresters call them. In 1903 he prepared a working plan for the Alice Holt woods belonging to the Crown. These labours brought him more and more into contact with British forestry.

On the 17th November, 1903, he gave a lecture on "Forestry" at the Royal Agricultural College, Cirencester, as Honorary Professor of Forestry at that Institution. On the 25th February, 1904, he delivered another lecture at Carpenters' Hall, in the City of London, on "The Forestry Problem in the United Kingdom." In these two lectures the author gave the outlines of his views on British forestry. Two more lectures were given by him in January and February, 1905, before the Royal Institution, on "Forestry in the British Empire." In the second of these lectures he dealt especially with forestry in the United Kingdom.

In the present instance it is proposed to examine the question, whether extended and improved forestry is of such importance to this country generally, as to justify any special

* The pamphlet was reprinted in the "Indian Forester"; see the number for April, 1886.

measures to be taken towards furthering it, and if so, what these measures should be. The subject may be divided into the following four sections :—

1. The importance of the forestry problem to the nation.
2. The measures which should be taken in this country to insure the benefits offered by forestry.
3. The afforestation of surplus lands.
4. The treatment of some types of British woodlands.

Section I.—The Importance of Forestry in the United Kingdom.

1. *The Æsthetic Effect of Forests.*

This is an aspect which plays a great part in the case of most of the woodlands at present existing in this country. Just compare the difference of feeling created, even in the mind of the least sentimental person, on passing through a bare country side without a tree for miles around, and on wandering, especially on a warm summer day, through a country where fields and meadows alternate with inviting woodlands. It is no wonder, therefore, that we find in most parts of this country fine parks and artistically placed woodlands which render Britain so beautiful and attractive. It is a subject which has been repeatedly dealt with, and upon which a good deal more can be said. On the present occasion only the influence which forests have upon the physical and moral development of the people shall be mentioned. By developing a taste for the beauty of landscape, forests greatly contribute towards the peace and contentment of mind of the dwellers in the country and help to counteract the unwholesome fever of emigration to the big towns.

2. *Effect of Forests upon Climate.*

It is well known how beneficially woodlands act in giving protection against strong winds. Indeed, many woods were created so that they might act as shelter belts for the benefit of fields and pastures, as well as for man and beast. An incidental further benefit of such woods consists in the fact

that they act as breeding and resting places for useful birds, the great insect destroyers in agricultural districts. It need hardly be pointed out that woods serve as excellent game coverts, and it is chiefly for this purpose that a great portion of the existing woodlands are maintained in this country. As regards the effect of forests on rainfall we need not trouble ourselves. In the first place, that supposed effect is as yet very doubtful, and, secondly, we have in this country quite enough rain and frequently a good deal to spare.

3. *Effect of Forests upon the Stability of the Soil.*

Forests assist in preventing erosion, landslips, the silting up of rivers and low lands, and they arrest shifting sands. The rain water which falls on bare hill sides rushes down, disintegrating the soil and carrying it into the water channels which generally deposit it on lower ground and often on fertile fields and meadows. This effect has not yet done irretrievable damage in Britain, but the commencement of such detrimental action can easily be seen. Anyone who has travelled to Scotland must have seen dozens of places in Northumberland where the water has cut into the hill sides and produced indentations, which certainly will go on increasing if nothing is done to arrest such action. The same may be seen, and in a more aggravated form, on proceeding from Chester to Holyhead. Unless such mischief is stopped in time, it may afterwards necessitate the construction of costly works, such as embankments, dams and weirs. What this means will easily be seen by those who pay a visit to the French Alps.

Again, there are unmistakable signs, in many parts of the country, that peat bogs are increasing, owing to the unprotected state of extensive waste lands. Indeed, in many quarters the opinion is held that the extensive peat bogs of Ireland came into existence since the original forests were destroyed. At any rate, there can be no doubt that, year by year, the bogginess of the open lands in the New Forest is increasing.

These few instances will show that the indirect effects of woodlands are of considerable importance.

4. *The Produce of Forests.*

While the indirect effects of forests are sometimes difficult to estimate, it is comparatively easy to assess the direct effects, that is to say, the benefits which a nation derives from them through the produce which they yield. Here, again, we have to do with a great variety of things, such as timber, firewood, fruits, leaves, flowers, bark, turpentine, fibres, grass, moss, peat, game and many other things. Some of these articles are of importance in agriculture and estate management generally.

Before dealing specially with timber and game, it may be pointed out that the United Kingdom imports annually large quantities of forest produce which are of the utmost importance in various industries, as the following data will show:—

ANNUAL IMPORTS OF MINOR FOREST PRODUCE.

Average of the Years 1900 *to* 1904.

	Value £
Caoutchouc	6,027,050
Gutta-percha	1,180,296
Dye stuffs	518,014
Dye wood	249,412
Vegetable fibre	779,190
Myrabolans	170,876
Galls	76,807
Gums	1,305,683
Oil of Turpentine	834,574
Rozin	528,728
Pitch	42,966
Tar	92,706
Total	11,806,302
Wood pulp	2,259,237
Grand Total	£14,065,539

Some of these articles could be produced in this country, such as wood pulp, but the majority cannot be grown or manufactured in Britain.

a. Forests and Game.

Unfortunately, the old taste for the chase has now changed into the love of killing as many head of game as possible within the shortest possible space of time. This holds good especially with regard to red deer, grouse, pheasants and rabbits. Let us begin with red deer. These are chiefly found in Scotland, where enormous areas are set aside for the purpose of rearing them Such areas contain either no woods at all or remnants of former forests. The object is to procure as many stags as possible, so as to raise the shooting rent to a maximum. But the animals shot on these deer ranges are nothing like the fine beasts found in woodland areas. The pleasure of stalking a king of the forest and carrying home a fine trophy is far superior to bringing home three or four heads, such as are now obtained in Scotland. If a larger proportion of the Scotch forests were once more brought under wood, we should, no doubt, improve the breed, and at the same time increase the revenue from the lands in question by the sale of timber.

The grouse, on the other hand, requires open lands, but there is room enough in Scotland, with its nine million acres of waste land, for the rearing of grouse, even if a fair proportion of the land were afforested.

As to pheasants, it is easy to show that they can be reared, in great numbers without interfering with the economic management of the coverts. This subject will be dealt with in Section IV.

Rabbits, however, are a plague which more and more endangers a rational utilization of the soil. If a minute investigation were made into the damage done by rabbits, not only in forests but also on agricultural lands, people would be astonished at the amount. If the killing of large numbers of

rabbits is desired by "chasseurs." well and good; let them establish rabbit warrens and please themselves to their hearts' content, but let us make an effort to free, at any rate, agricultural lands from this plague, which now seriously reduces agricultural crops and demands an enormous outlay on wire-netting fences.

No doubt, shooting rents are a convenient income to the proprietor. If, however, the areas are compared with the income, it will be found that the rent is not nearly as large as is sometimes assumed. The author has, for years past, taken advantage of every opportunity to inquire into the matter, and he is satisfied that, all round, shooting rents fall short of a shilling an acre. There are occasional areas which give half-a-crown and even more, but there are also immense areas which give only a few pence per acre. On the other hand, much of the land, if put under forest, can be made to give a considerably higher revenue, even after allowing compound interest on all outgoings.

b. Forests and the Supply of Timber.

The home production of timber, probably, does not exceed two million tons. Over and above that, we import rather more than ten million tons, so that only 16 per cent. of all the necessary timber is produced in the country. The increase in the annual imports between the years 1864 and 1899 amounted to six and three-fifth million tons, equal to an average annual increase of 190,000 tons a year. The average annual increase during the last five of these years amounted to 332,000 tons. A further considerable increase has occurred since the year 1899.

Of this timber, 87 per cent. is pine and fir.

3 ,, ,, ,, oak.

10 ,, ,, ,, teak, mahogany, and other furniture and fancy woods.

Hence 90 per cent., or nine million tons, are material which can be produced in this country by the afforestation of about six million acres of land.

The timber imported in 1899 came from the following countries:

From Canada	=	1,897,000 tons
,, Other British possessions .	=	318,000 ,,
Total from British possessions	=	2,215,000 ,,
From Russia	=	2,242,000 ,,
,, Sweden	=	2,396,000 ,,
,, Norway	=	863,000 ,,
,, France	=	825,000 ,,
,, Germany . . .	=	403,000 ,,
,, The United States . .	=	992,000 ,,
,, Other foreign countries .	=	168,000 ,,
Total from foreign countries .	=	7,889,000 ,,
Grand total of imports . .	=	10,104,000 ,,

For these imports we paid:

To British possessions . . .	£6,687,000
,, Foreign countries	£18,990,000
Total . .	£25,677,000

Some nineteen million pounds went to foreign countries, except in so far as British ships brought the timber across the sea.

The 90 per cent. of timber, which could be grown in this country, represents a value of £20,623,000. But this is not all. Consider what industries, using wood as their raw material, might not spring up, if the timber were produced at home. In 1902 we imported 525,000 tons of wood pulp, for which we paid £2,398,215. Surely, if we can grow anything, we can grow timber fit for wood pulp! Then, remember

the toys and games, of which we imported in 1902 to the value of £1,240,840. Again, there are imports of

		£
Wood pulp boards	value	256,903
Matches	,,	419,099
Brooms and brushes . . .	,,	317,665
Baskets and basket ware . . .	,,	262,116
Other sorts of wood, including wood ware, etc.	,,	1,820,520

If all these items are added up we find that we now pay for imports of timber and the above-mentioned articles the sum of twenty-seven million pounds, all of which could be produced in this country. Imagine for a moment, what an amount of labour it would require to produce these articles at home, and all the time we do not know what to do with our "Unemployed." Is it not time to wake up and do something?

We have, for instruction and as an example, to glance only at the beech woods in the Chiltern Hills, the existence of which caused the development of an extensive chair industry. Tens of thousands of workmen are employed in that industry, which would never have seen the light of day without these forests. The industry has now developed to such an extent that it consumes the beech and other timber from the surrounding counties, as well as large quantities imported from abroad. There can be no doubt that similar industries will spring up in other parts of the country, if we create the necessary woodlands and thus produce the raw material.

c. Uncertainty of Future Supplies of Timber.

If we sit still and do nothing, can we rely for any length of time on getting the necessary timber, in fact, as long as we can pay for it? The reply is, "By no means."

To begin with, Britain is not the only importing country in Europe. As a matter of fact, most European countries import and only a few export timber. This is illustrated by the following statement:—

NET IMPORTS AND EXPORTS OF EUROPEAN COUNTRIES.

(*Average Data, calculated from the Returns of Five Years.*)

Country	Imports Tons	Exports. Tons
Great Britain and Ireland	9,290,000	
Germany	4,600,000	
France	1,230,000	
Belgium	1,020,000	
Denmark	470,000	
Italy	420,000	
Spain	210,000	
Holland	180,000	
Switzerland	170,000	
Portugal	60,000	
Bulgaria	50,000	
Greece	85,000	
Servia	15,000	
Roumania		60,000
Norway		1,040,000
Austria-Hungary		3,670,000
Sweden		4,460,000
Russia, with Finland		5,900,000
Total	17,750,000	15,130,000
Net imports into Europe	2,620,000	

It will be observed that the following countries import timber (net): Great Britain and Ireland, Germany, France, Belgium, Denmark, Italy, Spain, Holland, Switzerland, Portugal, Bulgaria, Greece and Servia. The exporting countries are: Roumania, Norway, Austria-Hungary, Sweden and Russia If we draw the balance for the whole of Europe, we find an annual deficiency of 2,620,000 tons. For a good many years past, Europe has not been able to supply, from within its own limits, the timber required by the several nations. It may be added that the deficiency is increasing. The total annual

increase in net imports of all European countries of late years amounted to 600,000 tons. If the same rate of increase lasts for another ten years, and there is every sign of it, an additional six million tons a year will be required.

But it will be said, why not work the forests in the exporting countries more heavily? In reply it must be pointed out that Norway is already working her forests with a heavy deficit by cutting more than grows annually, and this has been known for some time past. Sweden was hitherto considered solvent in this respect, but official information lately supplied by our representative at Stockholm and published in a Parliamentary paper shows that, according to the statements of the Swedish officials, the forests of that country are now being worked with an annual deficit of 106,000,000 cubic feet. Here, then, is another of our most important sources of supply also beginning to fail us. Of the Austria-Hungarian exports only small quantities come to this country, because half of them go to Germany and the rest to various other countries. The exports from Roumania are small and do not affect the question under consideration. There remains, then, Russia with Finland. That country has enormous areas of forest, but it has far greater areas without it. Moreover, a large proportion of the so-called forest area does not produce timber fit for export. Russia's population and industries are rapidly increasing. Different views are taken of her capability to maintain her export of timber. The author's personal opinion, having weighed the evidence on both sides, is that Russia is a doubtful factor. At any rate, the authorities had, before the outbreak of the Russo-Japanese war, taken measures to restrict the working of the forests, for fear that some time hence the available out-turn of the forests might fall short of the requirements of the home consumption.

It has, more than once, been said that the forests of Siberia are of sufficient extent to make good any deficiency which may occur. How erroneous such views are will be seen from the following extract from a recent report of the Russian Finance

Minister. He says:—"In dealing with the settlement of immigrants in Siberia, it will be necessary to give special attention to the forests, the actual condition of which threatens Siberia with great perils in the future. Almost everywhere the forests have either been totally destroyed or devastated by the local people, so that they have almost lost their value. Absence of supervision and the rise in the price of forest produce, following the construction of the railway and the development of steam navigation, are causes of the exhaustion of Siberia's forest richness. The principal causes of destruction are, however, forest fires. Year by year enormous extents of the finest pine forests are ruined by fire. In the arrondissement of Altai one can see every year tens of thousands of acres of forest burnt, and these fires uncover the soil which has already commenced to become moving sand. In consequence of this enormous destruction of forests, the climate of Siberia is actually deteriorating, and this is probably the cause of the famine which reigns since two years in the Altai. For these reasons, it is absolutely necessary to introduce at once a proper forest organisation into Siberia."

After such testimony by the Russian Finance Minister, Siberia may just as well be struck off the list of countries upon which those relied, who have as yet doubts regarding the coming shortness of timber supplies. Let us hope, that matters are less serious in other parts of the Russian Empire.

On the whole, there can be no doubt that the pressure in Europe is increasing and is likely to continue doing so in the future. This is indicated by the course which the average price of timber has followed in Britain. From about 1870 to 1888 the price of timber fell, chiefly owing to the great development of the means of transport by sea; from 1888 to 1894 prices were steady, but in the latter year a gradual rise set in which in 1899 amounted to 18 per cent. The South African War brought some disturbance, but in 1902 a further advance occurred, so that the total rise during

the eight years, 1894 to 1902, comes to 20 per cent. There can be no doubt that we shall never again see the low prices of ten to fifteen years ago, because the more accessible forests in European exporting countries have been heavily worked, if not exhausted, so that the timber for export has, year by year, to be carried over longer distances before it reaches the sea.

But what about the non-European countries? The following table will illustrate the position of affairs:—

NET IMPORTS AND EXPORTS OF NON-EUROPEAN COUNTRIES.

Country.	Net Imports Tons	Net Exports Tons.
South America	330,000	
Egypt	200,000	
Australasia	160,000	
Cape of Good Hope	150,000	
Natal	50,000	
China	50,000	
Mauritius	20,000	
Ceylon	10,000	
Japan	5,000	
West India, Mexico, Honduras, etc.		13,000
West Coast of Africa		28,000
India		55,000
United States of America		1,020,000
Dominion of Canada and Newfoundland		2,144,000
Total	975,000	3,260,000
Net export of non-European countries		2,285,000

The total net exports very nearly balance the net imports of European countries as given above; the small difference could not be traced. It will be observed that the only

exporting countries of importance are the United States of America and Canada.

Australasia has as yet large stores of timber which consist, however, chiefly of hardwoods. An increasing quantity of it is exported, but she imports so much pine and fir that as yet a balance is shown against her.

The United States are working with a heavy deficit as compared with production, so that they have, in steadily increasing quantities, to draw on Canada. The gravity of the position has been recognised, and great efforts are being made to guard against a future timber famine in that country. Instruction in forestry is being given at two universities and some forty other educational establishments; State forests are being created at a rapid rate, and even private forest lands are brought under systematic forest management. The United States have now at Washington a well-organised "Bureau of Forestry," presided over by Mr. Gifford Pinchot, a wealthy American, who studied forestry chiefly in Germany, but also in France and Switzerland. He is assisted by a number of gentlemen at headquarters and a large staff of field assistants.* This staff is busy in gradually introducing systematic management into the State reserves and into private forests. Can we not learn something from this?

Canada has as yet great stores in her 266,000,000 acres of real timber lands, especially of coniferous timber. If the authorities in these self-governing colonies could be induced to introduce systematic management into the more important forests, that country might for ever supply the rest of the world with the necessary coniferous timber. Some mild efforts have been made by the Governments and even forestry societies started, but the interests of the lumber trade are very great and powerful, and in the meantime, the destruction of the forests by reckless cutting and fires goes on As pointed out in Chapter IV., there is now a chance of a thorough change being introduced. Let us hope that this will be the case.

* For further information, see Appendix.

5. *Conclusions.*

On the whole, then, the following conclusions seem justified:—

1. We require enormous and ever-increasing quantities of timber.
2. Prices are likely to be higher in the future than they were in the past.
3. Supplies from outside rest on a very unsafe basis.
4. An increase of the woodlands in this country, if brought about by the afforestation of surplus land, will keep a large amount of money in the country, lead to an increased demand for labour in the establishment and management of such woodlands, and it is likely to cause the development of additional industries which use wood as their raw material.

Section II.—Measures to be taken in the United Kingdom.

1. *Land available for Afforestation.*

The land in the United Kingdom, excluding water, is at present used as follows:—

Utilisation of the Land in the United Kingdom.

Countries	Area of Dry Land Acres.	Area under Crops and Grass Acres	Area of Woodlands Acres	Mountain and Heath Land. Acres	Other Lands Acres
England .	32,380,991	24,679,966	1,665,741	2,324,624	3,710,660
Wales . .	4,748,468	2,810,824	181,610	1,270,470	485,564
Scotland .	19,068,958	4,897,169	878,765	9,289,378	4,003,646
Isle of Man, and Jersey	185,453	124,650	869	29,729	30,205
Ireland .	19,322,798	15,230,591	303,023	2,226,867	1,562,317
Total . .	75,706,668	47,743,200	3,030,008	15,141,068	9,792,392
Percentage	100	63	4	20	13

It will be observed that 63 per cent. are used for crops and grass, 4 per cent are woodlands, 20 per cent. mountain and heath land and 13 per cent. other lands. The latter include, in the case of Ireland, 1,124,111 acres of turf bog and 428,662 acres of marsh.

The area of woodlands, 4 per cent. of the total area, is smaller than that of any other European country except Denmark. Again, only some 67,000 acres, equal to 2¼ per cent. of the British woodlands, belong to the State, or rather the Crown, a percentage which is smaller than in the case of any other European State. In France the percentage is 11, in Norway 12, in Austria-Hungary 12, in Sweden 20, in Germany 33, and in Russia 60. The area under forest per head of population is—

In the United Kingdom . . .	0·1 acres.
In France	0·6 ,,
In Germany	0·6 ,,
In Austria-Hungary	1·1 ,,
In Russia	6·1 ,,
In Sweden	9·1 ,,
In Norway	9·9 ,,

Considering all these matters, there can be no doubt that an effort must be made to increase the area under timber in this country. Even apart from the 9,792,392 acres of so-called other lands, about which it is difficult to obtain detailed information, we have over fifteen million acres of mountain and heath land to select from. A large proportion of these lands are used for light grazing and as shooting grounds, but as stated above, the average rental value is not more than a shilling an acre. Even the best of them rarely give more than half-a-crown, while there are millions of acres in Scotland and Ireland which give only a few pence a year per acre or nothing at all. A large proportion of these lands could be made more remunerative than they are at present, even allowing compound interest on all outlay.

2. *Climate and Soil.*

It is sometimes said that it is all very well to urge extended forestry in the United Kingdom, but that home-grown timber is of a quality inferior to that of the timber now imported from abroad. This is to a very large extent a fallacy. The late Forestry Committee had abundant evidence that we can, and do, produce timber of a quality at least equal to that imported in the case of oak, ash, beech, and larch. As regards Scotch pine and spruce, frequently an inferior quality has been produced, because the trees were given too much growing space and in consequence laid on too broad annual rings. They are frequently cut too young. Proper sylviculture can remedy this.

On the other hand, the imported timber of nearly all species comes to us in pieces which are straighter and more free of knots than the ordinary home-grown timber. This is, again, due to faulty sylviculture in our own woodlands. Too heavy thinnings and too much growing space to the individual tree while young account for this. If we treat our forests in a more rational manner, we shall produce just as fine timber as that now imported.

As regards the climate, there is practically nothing better to be desired as far as the production of timber is concerned, however unpleasant it may be in other respects. We have, generally speaking, mild winters and cool summers. Of rain we have plenty, often too much, while snow and ice are not nearly so frequent as in other northern European countries. Unfortunately, of gales and strong winds we have more than a fair share, but, with proper management, their injurious effect upon forest growth can be considerably reduced. Let foresters learn to cut against the prevailing wind, and the damage by gales will be only a fraction of what it is if the reverse direction is followed. It has been said that British conditions cannot, in this respect, be compared with those in continental countries. That, however, is a mistake. The woods on the west coast of France are exposed to the terrific gales passing over the Bay of Biscay, and yet regular forest management is

possible. The woods in the higher parts of the Black Forest are exposed to strong gales, and although windfalls do occur, they disarrange systematic management only to a moderate extent, as long as the precautions indicated above are observed. When mistakes are made, the results are similar to those so frequently experienced in this country. To illustrate this, the appended photographs are given, which were taken in the author's presence.

On the whole, the climate of Britain, at any rate up to the centre of Scotland, though it may not be equal to that of a great portion of France, compares favourably with that of Northern Germany, Norway, Sweden and Northern Russia, whence we import some six million tons of timber a year.

In coming now to the question of *soil*, it may be said that we have it of good, bad and indifferent quality, just as in the above-mentioned countries. There is, however, one great drawback in the case of afforesting land which has been lying waste for long periods of time, inasmuch as it has suffered in yield capacity owing to continued exposure and the dissipation of all organic matter. In such cases, there will be some difficulty in the beginning, and a start must be made with species which are little exacting. When a suitable forest crop has once more been established on the areas, the producing power of the land will increase in the same degree as organic matter accumulates in the soil, and then more exacting species can be introduced as a second crop. The loss of increment in the beginning is a penalty which we shall have to pay for neglect in the past.

What we require are improved sylvicultural methods, and the late Forestry Committee pleaded, in the first instance, for improved instruction in forestry. This recommendation has already borne fruit. Special forestry branches have been added to the Royal Agricultural College at Cirencester and to the Kent and Sussex Agricultural College at Wye; both institutions are for the instruction of landed proprietors or their sons, or young men preparing for the position of estate

Windfalls in a *Spruce Wood*, situated in the Herrenwies Range of the Black Forest
Elevation, 2,900 feet above the sea
(From photographs by Mr P Barry)

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managers. A forest school for woodmen has been started by the Commissioners of Woods in the Forest of Dean. This step is likely to be of great importance. It provides for the training of a class of men who are wanted, not only for the Crown Woods, but also by private proprietors who own a limited area of woodlands. The instructor in charge has made a fair start under the supervision of the Deputy Surveyor, Forest of Dean, and it is to be hoped that the school will prosper. The students, who are of the woodman class, have theoretical instruction on two days in each week, and they work in the forest the remaining four days.

A forestry branch exists at the Durham College of Science. Instruction in forestry has for a series of years been given at the University of Edinburgh, and there is every prospect of its being considerably enlarged. Another forest school has been established in Wales. Further measures in the same direction will, no doubt, follow, especially if the State authorities see their way towards helping a little more than has been done in the past. Owing to the abolition of Coopers Hill College, the School of Forestry for the training of the probationers for the Indian Forest Service has been transferred to the University of Oxford. At that place, not only the said probationers but any other member of the University can obtain the Diploma of Forestry. In addition, other members of the University can take part in any branch of the instruction in forestry, an opportunity which, it is hoped, the sons of landed proprietors will utilise to obtain some sound views regarding economic forestry.

It is understood that Cambridge also is about to add a forest branch to the University.

3. *Proprietorship of the Land.*

There exists one great difficulty, inasmuch as the bulk of the mountain and heath land is private property. In some cases, the proprietors are not inclined to plant, and in others they cannot afford to meet the initial expense of planting, or

forego the present small income from the land until the plantations commence to yield a return. The question thus arises, what can be done to overcome the difficulty? There are various ways of meeting the case:—

1. The State may encourage afforestation by private proprietors, by providing the means of education in rational, economic forestry and by making advances at a low rate of interest to proprietors who are short of cash.
2. The State may acquire surplus lands and afforest them.
3. Municipalities may acquire surplus lands and convert them into communal or corporation forests.

a. Private Proprietors.

All three agencies ought to be put into motion, but as matters stand we must look chiefly to the first one. The question of education in forestry has just been dealt with.

It seems of the utmost importance that arrangements should be made to give advances to landed proprietors, who are willing to plant but unable to meet the initial expenses, at the rate of interest at which Government can borrow plus a suitable addition by way of a sinking fund. Such advances should cover the actual outlay for planting, and the plantation would remain mortgaged to Government, or other security given, until the advance has been paid back. Let us take an example: A proprietor wishes to plant 1,000 acres at a cost of, say, £5 an acre. This would involve an outlay of £5,000, a sum which he may be unwilling to expend, or unable to raise except at a high rate of interest. Under the plan suggested above, he would have to pay about £150 to £175 a year, which he may be able to afford. After some twenty years (and frequently sooner) the thinnings would commence, when he would be in a position to pay off the debt by degrees, and then the plantation would give him an increasing income. The State has agreed to pay a large sum of money for the benefit of the Irish cultivators. Would it be too much to ask such a small consideration as the one just indicated for another set of loyal subjects?

Then, there is the manner in which rates and taxes are assessed upon woodlands. The late Forestry Committee was of opinion that it could be improved and made more just, but it is a difficult subject.

Another serious matter is the question of the rates charged by railway companies for the carriage of British timber. These rates are higher than those charged on foreign timber. The Forestry Committee also dealt with this subject, and it is to be hoped that the complaints of timber merchants may be taken up at an early date. There is, however, one point to which attention must be drawn. It was given in evidence before the committee, that in most cases the foreign timber was easier to handle and packed better in the trucks, so that the railway companies were bound to charge something for British timber over and above the amount charged for foreign timber. This drawback will disappear when we begin growing cleaner timber.

Finally, it should be mentioned that some county councils have attempted to make timber merchants pay for damage done to roads on account of specially heavy traffic. Such an attempt is absolutely unfair and, it is to be hoped, unlawful. Planted land pays rates and taxes for a long series of years during which it causes little or no traffic. If the proprietor, or timber merchant, which comes to the same thing, is called upon to pay extra for traffic when the crop becomes mature, he is made to pay rates twice over. The matter must be fought out, either in the law courts, or in Parliament.

b. The State as Proprietor.

It has often been urged that the State should acquire large areas of surplus lands and put them under forest. Indeed, an enthusiastic gentleman actually proposed that Parliament should vote one million pounds a year for the next hundred years, so as to purchase and afforest seven million acres of land. Without going as far as that, there can be no doubt that the State could do something in that direction. From time to time suitable tracts of land come into the market, and

there is no reason why the State should not acquire such land. On the whole, however, cases of that kind are comparatively rare in England, but probably more numerous in Scotland. In Ireland the State could do something substantial in connection with the carrying into effect the latest Irish Land Act. Many of the estates, especially in the congested districts, contain large areas of waste land which are not required by the new proprietors. Such areas might be acquired by the State and converted into State forests. The price of such land would probably be less than £1 an acre. No doubt, such a procedure would be beset by difficulties, especially in the beginning. It has been said that the adjoining farmers would destroy the plantations, but the difficulty can be overcome by making it the interest of the surrounding population to preserve the woods. The forests will provide additional work, and by and by tend to create various local industries, all of which will make the people the friends of the forests, and not their enemies.

The expenditure under this head need not frighten the taxpayer, as a beginning might be made on a small scale. Sir Herbert Maxwell, in a paper which he lately read before the Society of Arts, proposed an allotment of £10,000 a year to begin with. Experience would show, whether, and to what extent, this sum should be increased.

c Municipalities as Proprietors

It need scarcely be pointed out that the City of London already possesses a municipal forest, the Epping Forest. That area is, no doubt, managed with a view to its serving as a recreation ground for the inhabitants of London, and not for economic reasons. It could continue to serve its present purpose and yet yield a revenue, provided excessive sentimentality were somewhat curbed.

There is, however, another matter which, year by year, is becoming of greater importance to all our large towns, and that is the question of the "Unemployed." It is well known

how serious the matter becomes every winter, how special efforts are made to deal with it, and yet how much remains to be done. Afforestation offers one of the means of solving the difficulty. The bulk of forest work can be done at those times of the year, when the question of the unemployed is most pressing, that is in winter. Why should the great City of London, yea, one or other of the City Companies, not buy a few tracts of mountain land, where forest work could be given to the unemployed during winter? It is true that extensive tracts of surplus land cannot be found in the immediate vicinity of London, but railway communication is so complete that a moderate distance does not make much difference. The agricultural returns show that there is plenty of land to choose from for all the large towns in England and Wales :—

MOUNTAIN AND HEATH LANDS IN ENGLAND AND WALES.

	Acres		Acres.
In the county of Surrey	= 13,136		
,, ,, ,, Kent	= 6,686	=	36,502
,, ,, ,, Sussex	= 16,730		
,, ,, ,, Suffolk	= 30,732	=	74,833
,, ,, ,, Norfolk	= 44,101		
,, ,, ,, Yorkshire		=	546,388
,, ,, ,, Northumberland	= 471,303		
,, ,, ,, Cumberland	= 262,859	=	996,868
,, ,, ,, Durham	= 53,874		
,, ,, ,, Westmorland	= 208,832		
,, ,, ,, Devonshire	= 160,188		
,, ,, ,, Cornwall	= 56,715	=	295,260
,, ,, ,, Somerset	= 51,031		
,, ,, ,, Dorset	= 27,326		
In other English counties		=	374,773
Total in England		=	2,324,624
In Wales		=	1,270,470

There is no necessity for London, or any of the other large towns, to launch out upon a big scheme at once, but there is no reason why an experiment should not be made on a moderate scale. Let us take Surrey, Kent and Sussex. Out of the 86,502 acres of mountain and heath land a few thousand acres might be acquired. On this area planting on a small scale should be started under an efficient superintendent, so as to train a small establishment to the work. The men so trained would subsequently act as foremen. When pressure comes in winter-time in London, the unemployed would be sent to the estate and employed in preparing the land for planting by draining, fencing, and digging planting holes on such a scale that sufficient work is provided for the men until hard times pass, and they can return to their ordinary occupation, a certain number perhaps being retained to do the actual planting. Towards spring the staff of workmen would be reduced to its permanent strength, which would be busy with nursery work during spring, summer and autumn.

A certain outlay for housing would, of course, have to be incurred, but the work done on these plantations would lead to some tangible results and not to waste, as is so often the case with relief works.

If the experiment turns out a success, and with proper arrangements it should do so, further land might be acquired in the above-mentioned three counties, or in Suffolk and Norfolk, or even further north.

If London and other large cities embarked on an enterprise like that sketched above, a considerable area might gradually be brought under forest; it would help to overcome the difficulty of the unemployed and add considerably to the quantity of timber produced in the country. Moreover, it would lessen the emigration from the country into the large cities. This emigration has gradually developed, until it has become a calamity; it can only be cured gradually by providing more work in the country and making life in it more attractive.

In many cases, operations of this class may be combined with the utilisation of catchment areas for waterworks. The Corporation of Liverpool has extensive gathering grounds at Vyrnwy in North Wales, where plantations have already been commenced. Here a fine example of utilising mountain lands is being given, which has already been imitated by other corporations. In spite of much discussion as to the advisability of afforesting gathering grounds, there can be no doubt that it is the best means of keeping the water pure and of regulating its flow, a fact which will be affirmed by those who have enquired into the magnificent works carried out by the town of Verviers in Belgium. Its gathering ground on the banks of the river Gileppe is under forest, and with the most satisfactory results.

4. *The Labour Question.*

And this leads to the labour question generally. If afforestation were undertaken on a large scale, there is no reason why five or six million acres should not gradually be brought under wood, thus producing the bulk of the ordinary timber required by the country. Every acre afforested would require an expenditure on labour of, say, £2 for planting. After the forests have been established, every acre would require about five days labour a year, or a total of thirty million days for the work in the forests. Then there is the large business of transport and working up the timber, as well as the various industries which would spring up. On the whole, it is estimated that not less than a population of two and a half million people would find additional work in the country, counting five members for each family.

There is yet another point of great importance. It has already been indicated that most forest work can be done in winter, when agricultural work is slack; hence the two kinds of work can be made to fit in with each other and thus make available more labour for agriculture during summer. This

would be an inestimable benefit for agriculture which is at present so short of labourers.

Nor must the beneficial effect which work in the open country would have upon the physical condition of the people be overlooked. A good deal has of late been heard about physical deterioration. Surely, a measure which enables a larger proportion of the nation to live under the healthy conditions of a country life must be welcomed by, and commend itself to, all who would wish to improve the physical condition of the people.

5. *Conclusion.*

It is not a fanciful problem which has been placed before the reader, but a scheme which is realisable, if we really put our shoulders to the wheel. Let us hope that the matter will not be pushed aside with a light heart by those who can help to realise it.

The author has urged the subject upon public attention for the last twenty years, and a slight movement to take it up is now on foot. May that movement increase in vigour, so that at last something substantial may be done, which, without doubt, will prove a lasting benefit to the United Kingdom and its people.

A short time ago the subject was before the House of Commons in connection with the question of the unemployed, and it also came before the House of Lords, when the Earl of Onslow, Chairman of the Board of Agriculture, spoke in a very sympathetic manner. He announced "that the Treasury had promised assistance in the foundation of at least two forest schools in England, one for the instruction of young men who were likely to become landowners or land agents, and the other for woodmen. The former he should prefer to see attached to one of the great Universities. There was a strong feeling in the country that we should not be behind foreign nations in our knowledge of woodcraft, and that our resources ought to be made more use of. This method of utilising the

soil his Department was most anxious to encourage, and by the training of young men of both classes in the science of forestry they believed that, by making a small beginning now, they might be enabled to lead up in the course of years to great results. The time might come, therefore, when this country would be able, far more than at present or in the past, to rely upon its own resources for the production of forest timber."

If the Government were to establish a central authority with a few experts to manage any land afforested on behalf of the State, and to go about and advise intending planters, a good beginning might be made. The collection of useful statistics might be made part of their duty. Such statistics are of the first importance, as will be shown in the next section when dealing with the yield and financial results of afforestation.

Section III.—The Afforestation of Surplus Lands.

The treatment of forests depends on the objects which it is proposed to realise. It rests with the proprietor, in so far as his choice is not limited by the laws of the country, to determine in each case what these objects shall be, and then it becomes the duty of the forester to see that they are realised to the fullest extent and in the most economic manner. This fundamental principle should never be lost sight of. In these islands, nearly the whole of the existing woodlands belong to private proprietors. They desire, in the majority of cases, to have the woods so managed that they lend themselves either to landscape beauty, or the rearing of game, or the production of a particular kind of produce required in the management of estates. In such cases, economic working is beset by considerable difficulties. And yet, even under such conditions the objects of the proprietors may be realised and the woods be made to yield, if not a full, at any rate a fair return, while the proprietor must put down any deficiency in the income

against his pleasure, or against shooting rents, or the benefits derived by the rest of the estate.

Where the manager is not hampered in this way, and where economic forestry is aimed at, as it would generally be in the case of extended afforestation of mountain, heath and other waste lands, the question of finance would be of the first importance. The forester must decide what and how to plant and how to treat his woods, so as to realise the highest possible net returns. The answers to these and other questions practically require a treatise on Sylviculture and Forest Management, for which the reader is referred to Volumes II. and III. of this Manual of Forestry. On this occasion, only short remarks on the afforestation of mountain, heath and other waste lands and on a few selected types of woods, as they now exist in the country, can be offered.

1. *Soil and the Selection of Species.*

Many varieties and qualities of soil are found on the mountain and heath lands; hence the selection of the proper species to plant, in the first instance, is of the highest importance. No general rule can be laid down, and the selection must be made on the spot in each case. There is, however, a fundamental rule which runs thus: "*Never attempt to plant a species which is not thoroughly suited to the locality, in other words, which is not likely to thrive in it.*"

Every disregard of this rule is likely to lead to financial loss. It is quite astonishing how often the rule is sinned against. Sometimes the planter has not a sufficient understanding of what species is most likely to thrive best in a given case. This shortcoming must be met by proper instruction. In other cases, the planter has developed a fancy for a certain species and proceeds to plant it under all conditions. This is a most disastrous failing which the forester must combat with all his might. The subject of selection must be approached with an open mind and all personal fancies absolutely put on one side.

Different species make different demands on the locality, not only as regards the chemical, but also, and chiefly so, the physical conditions of the soil. Hence foresters divide the species according to their demands on the fertility of the soil. Some species, such as sycamore, ash, oak and elm, to do really well, require a fertile soil; others, such as chestnut, beech and silver fir, are somewhat less exacting; next come Norway maple, lime, alder, larch and spruce; less exacting again are willow, poplars, birch, Weymouth, Scotch and Austrian pine. As a general proposition it may be said that heavy soils are better adapted for broad-leaved species, and lighter soils for conifers. There are, however, exceptions; spruce, for instance, does well on heavy soils. A medium class of soils, called loam, practically suits all species; in the same degree as the soil becomes heavier, broad-leaved species should prevail, and *vice versâ*. The final selection of the right species is a difficult task, and the subject must be studied in detail.

Amongst the mountain and heath lands of this country, areas are, no doubt, found which can at once be planted with the more exacting species, but as the greater part of it has deteriorated in consequence of long exposure, it will, in the majority of cases, be advisable to let the first crop be a non-exacting conifer, such as Scotch, Weymouth and Corsican pine, and, in suitable localities, larch. These species will gradually improve the land, so that they can be followed by more exacting species.

2. *Pure Woods or Mixed Woods?* *

The question, whether to grow woods consisting of one species only, or woods containing two or more species intermixed, presents itself to every proprietor and forester in this country. Taste, as well as considerations based on economic grounds, differ much on this subject, and it seems

* See pages 68 to 88 of Vol. II., third edition, of this Manual

worth while enquiring, in which cases and under what conditions the one or other class of wood is indicated.

As to the question of taste, it is impossible to evolve any rule. Some proprietors prefer pure, others mixed woods. If we ask Nature the answer no doubt will be that in by far the majority of cases mixed woods are the rule, though the species may be arranged in groups of greater or smaller extent, according to the character of the locality and the requirements of the several species. Many people think that the old woods here and there found in this country are natural woods, but there can be no doubt that many of them are nothing of the kind. Indeed, there is, perhaps, not a single wood in England which does not owe its present condition to interference by the act of man, not even the so-called natural woods in the New Forest and in Epping Forest, about which so much has been written. As they appear to us now, they are the result, if not of actual sowing or planting, of the cutting-out of certain species which Nature had introduced, of coppicing, pollarding and other violent interference, not to omit the effects of cattle-grazing and fire.

Proceeding now to the economic aspect of the matter under consideration, the case may shortly be stated thus.—The object in view should be to manage woodlands so as to secure, *permanently*, the best possible results, whether measured by quantity and quality of produce, or by net cash receipts, or the interest which the invested capital yields. Stress is laid on the word "permanently." No doubt, a proprietor can, for a certain period of time, realize large returns from his woods; but in doing so, he may seriously injure the future yield-capacity of the land. Returns are legitimate only, if by their realization the property is not reduced in value, as measured by its yield-capacity. On thoroughly fertile soil and under a favourable climate the danger is, perhaps, not great; but where such conditions do not exist, and this occurs in the majority of cases at any rate so far as the soil is concerned, woodlands should be stocked

with such species and treated in such a manner that the yield-capacity of the locality is not reduced. On the contrary, it should in many cases be improved. And thus we arrive at the question whether pure or mixed woods are indicated, and in the latter case, how they should be arranged.

The beneficial effects of a full crop of trees upon the soil are brought about chiefly by the following two agencies :—

(1.) A dense leaf-canopy formed by the trees which protects the soil against the effects of the sun and air currents.

(2.) A layer of humus formed by the fallen leaves and certain plants which grow in the shade of trees, such as mosses, which covers the mineral soil and produces a suitable proportion of organic matter.

These two agencies secure to the soil fertility and, above all, a permanent supply of moisture, without which no crop of trees can thoroughly flourish. Whenever the above two conditions are fully secured, the yield-capacity of the soil is maintained and in many cases improved. Hence the answer to the question before us runs thus :—

"*Only trees which have a fairly full foliage and preserve a good leaf-canopy to an advanced age are fit to be raised in pure woods. Species which do not possess these qualities should be mixed with trees of the former kind.*"

Accordingly, foresters arrange the trees grown for economic purposes into two classes. To the first class of trees fit to be grown in pure woods belong the beech, hornbeam, silver fir, spruce and in a less degree sycamore, Weymouth pine, and Douglas fir. To the second class of trees belong larch, birch, poplar, ash, oak and sweet chestnut. Half-way between the two classes stand Scotch, Austrian and Corsican pine, inasmuch as they benefit the soil up to a certain age, say, forty or fifty years, after which they begin to thin out and join the second class. As a rule, the trees of the first class are shade-bearing, whereas those of the second are light-demanding, in addition to being thin-crowned. It so happens, however, that the second class comprises most of the valuable

timber trees, more particularly oak, ash and larch; hence mixed woods, in which these species form a prominent feature, are indicated in Britain, in preference to pure woods.

The next question is, how should such mixtures be arranged? Unfortunately, no rational answer has been given to it by many British foresters during the last two generations. Instead of following the good old plan and the ordinary laws of nature, as exhibited by older woodlands, modern foresters conceived the idea of cramming together on the same area about as many species as they could think of. Light-demanding and shade-bearing, quick-growing and slow-growing, spreading and conically-shaped, tender and hardy, conifers and hardwood, have been mixed together anyhow, without any reference to the habits and requirements of the several species in mixture. The natural consequence has been that the more aggressive species, especially conifers, such as larch, Scotch pine and spruce, took the lead and, being frequently unchecked by the hand of the forester, ousted the better kinds of hardwood and more particularly the oak. Only too many plantations of this kind can be seen in the south of England, as well as in the Midland counties, where the trees, which were originally meant to serve as nurses for valuable hardwoods, have actually killed the latter, or crippled them to such an extent that they have become useless. "The nurse has devoured the baby." It is indeed time that we return to more simple methods, that is to say, to mix only species which are in every way suited to each other, and to mix and treat them so that each has a chance of fulfilling the object for which it is reared.

3. *The Density of Forest Crops.**

In the previous section special attention has been drawn to the necessity of growing a forest crop so that the fertility of the soil is preserved, if not increased, and that the most valuable class of timber is produced. The question may

* See Vol. II., third edition, pages 149, 174, and 289, of this Manual.

therefore be asked, "What is the proper density of a forest crop?" or to put it differently, "What is the most suitable growing space to be given to each tree?"

The theory of the case is simple enough, and it runs as follows:—"*The density of a forest crop should be such, that the objects which the proprietor has in view are most fully realised.*" Hence if the object is to produce landscape beauty, it is in some cases desirable to give to each individual tree sufficient space to grow and spread in a natural way, while in others a group of massed trees may be desirable; no special rule can be laid down in this case.

When trees are grown for economic purposes, matters are different. Here, a balance must be struck between the preservation of the fertility of the soil and the production of high-class timber. For the former purpose it is best to keep the crop as dense as possible from start to finish; but such a procedure may seriously interfere with the second object, and it may involve heavy additional expenditure at starting.

In the case of natural regeneration, successfully carried through, as many as 50,000 or 100,000 seedlings may be found on an acre, and these are, after a comparatively short space of time, reduced to a limited number, the strongest taking the lead and suppressing the others. In this case, ordinarily no extra expenditure is incurred, and the bountiful regeneration provided by Nature causes the surviving plants to be pushed up by their less-favoured companions which are destined to die an early death. Similar effects may be produced by sowing large quantities of seed to the acre, but this causes additional expenditure. The latter is further increased, if dense planting is attempted; and it is a question for serious consideration, up to what extent dense planting is financially justified.

The question can be answered only through statistical data based upon numerous measurements and countings. Such data are not available in this country; hence we must have recourse to those collected in Germany and France, especially

in the former country. Investigations have been going on now for a considerable number of years, so that we have data based upon many thousands of measurements. The author has compared them with measurements made by him in this country, and he is of opinion that, on *average* land, the following are the most suitable numbers of trees at various ages, *whenever the production of clean timber is aimed at.*

NUMBER OF TREES PER ACRE.

Age of Wood.	Spruce	Beech	Oak.	Scotch Pine
40	1,100	950	850	750
50	700	600	550	500
60	500	420	370	400
70	400	320	270	300
80	300	250	220	250
90	260	200	180	200
100	220	180	140	170
110	200	170	120	150
120	190	160	100	140

The numbers in the above table refer only to soil of *average* quality. On first class soil the numbers are smaller, and on inferior soil larger. Figures for larch are not available at present, as, owing to the larch disease, that species is in Germany nowadays grown only in mixture with other species, especially beech. In the meantime, the figures given for Scotch pine apply, approximately, also to larch.

The appended five pictures will illustrate the proper density of woods grown for economic purposes.

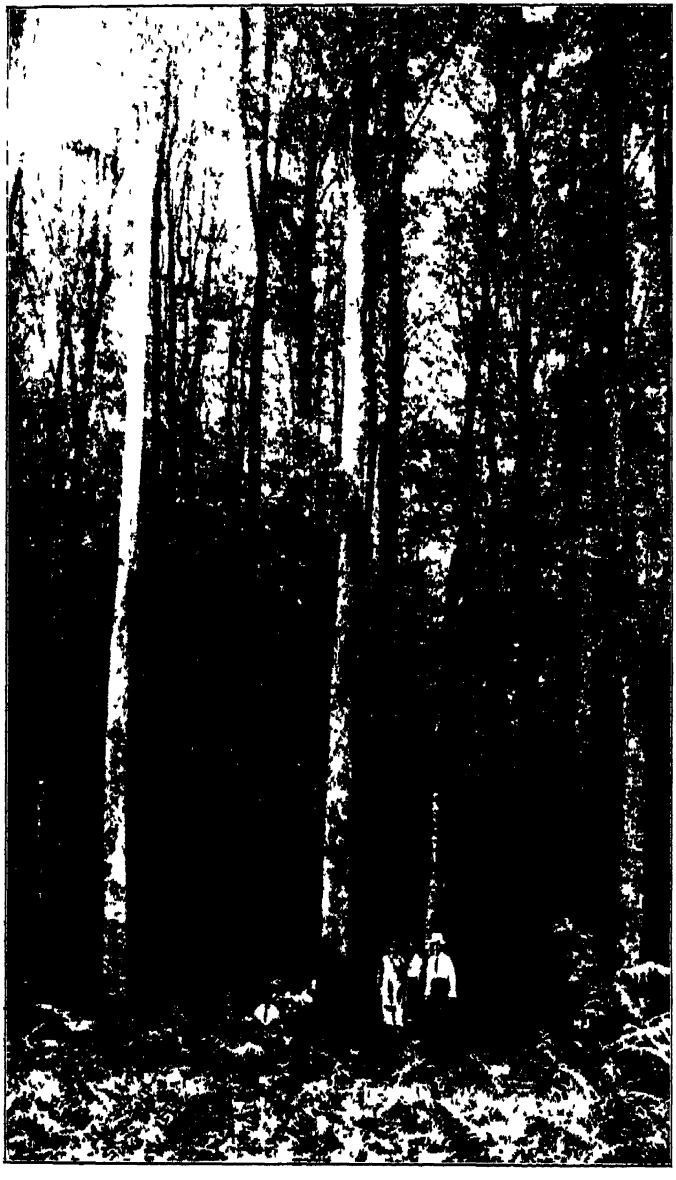
The matter, then, stands thus: We require at the age of forty years the above-mentioned numbers of clean stems, and the question is, how many plants should be put in to produce them and at the same time shelter the ground sufficiently. Here several matters must be considered. *Spruce*, though at first somewhat slow, does not develop very strong side branches, while the early thinnings are practically of no value, except where Christmas trees are saleable; hence 2,700 plants (4 ft. × 4 ft.) are sufficient to produce 1,100

Beech Wood in Buckinghamshire worked under the Selection System
Wood much too open.

[To face page 200

Natural Regeneration of *Beech* under a Shelter-wood (Spessart)
Up to a thousand seedlings to the square yard.

(From a photograph by W F Perrée, Indian Forest Service)



Mature *Beech Wood* in Normandy Originated by Natural Regeneration

Spruce Wood (Nassau), 60 Years Old

Total production of timber, quarter girth measurement = 9,310 cubic feet
Production per acre and year = 155 cubic feet, valued at £3 17s 6d

(From a photograph by R E Marsden Indian Forest Service)

Spruce Wood (Thuringia), 100 Years Old

Total production of timber, quarter girth measurement = 13,970 cubic feet
Production per acre and year = 140 cubic feet, valued at £5.

(From a photograph by F McClellan, now Professor of Forestry at the Royal Agricultural College, Cirencester)

clean stems at the age of forty years, provided the thinnings are done sparingly up to that age. The same holds good for *Douglas fir* and even *ash*. Closer planting increases the cost considerably and does not lead to appreciably better results. For *larch*, a planting distance of 4 ft. × 4 ft. is quite sufficient, and the thinnings can be fairly heavy, even below the age of forty years, because that tree wants a good deal of growing space without developing strong side branches. *Beech* requires somewhat more pushing, and 4,000 plants as a minimum to the acre are indicated when that tree is not regenerated naturally or by sowing the beech nuts in situ. *Oak* and *Scotch pine* have a tendency to develop strong side branches; hence they must be kept dense during youth; not less than 4,000 plants to the acre are required, and thinnings must be very sparingly carried out up to the age of thirty-five or forty years. In order to reduce the expenditure the best plan is to sow the seed of both species in situ, or, if this is not possible, to plant one- or two- year-old seedlings. In the case of oak, there should be 8,000 one-year-old seedlings to the acre, and they can be planted with a planting peg or the vertical notching spade. (See Figs. 65, 70 and 71, at pages 215 and 217 of Volume II. of this Manual, third edition.) The author is of opinion that most, if not all, of the old oaks (say more than a hundred years old) in this country have been raised either from naturally fallen acorns, or from acorns sown in situ. This is, without doubt, the best way of starting oak woods, but where the acorns are likely to suffer severely from mice, the next best thing is to plant one-year-old seedlings. Such plants invariably develop better leaders than plants put out when three or more years old. *Corsican* and *Austrian pines* may be treated as Scotch pine. Of *Weymouth pine* not more than 2,700 to 3,000 plants need be put to the acre.

The above remarks refer to the rearing of fine timber trees. Where only poles or pit timber are grown, the thinnings before the age of forty years are somewhat heavier, so as to produce a

certain diameter at an earlier age than is the case when growing timber trees with clean boles.

4. *Yield and Financial Results.*

In attempting to answer the question, what will be the yield and financial results produced by afforesting mountain and heath lands in this country, we meet with great difficulties. The most natural way would be to ascertain what the results of forestry on similar lands have been in the past That attempt would lead to disappointment, because, in the first place, it is almost impossible at present to obtain in this country data which would conclusively show what yield to expect, and, secondly, the few data available as to receipts and expenses are almost invariably rendered useless by the fact that many items are included under expenses which have little or nothing to do with forestry by itself. Again, it may be said that the returns hitherto yielded by British woodlands might in many, if not in most, cases be doubled by following the rules of rational sylviculture and by systematic management. An example will best illustrate this.

There is probably no country in the world which has such complete records of the past management of woods as the kingdom of Saxony. That country possesses 428,000 acres of State forests which occupy good, bad and indifferent land, less of the first and more of the others. The forests are chiefly found in the hills, where they go up to 3,000 feet above sea level. The systematic management of the forests was commenced rather more than 100 years ago, and authentic records are available from the year 1817 up to the present time. They show that the outturn in 1817 was 61 cubic feet of wood (timber and firewood) per acre, and 92 cubic feet in 1893, representing an increase of 50 per cent. The average stock per acre standing in the forests rose from 2,173 cubic feet in 1844 to 2,658 cubic feet in 1893, or an increase of 22 per cent. This shows that the forests were worked in

a conservative manner. The net returns, after paying for all possible items of expenditure, were as follows:

		Shillings.	
During the period	1817—1826 =	4	per acre and year.
„ „ „	1827—1836 =	4·2	„ „ „ „
„ „ „	1837—1846 =	4·7	„ „ „ „
„ „ „	1847—1856 =	6·3	„ „ „ „
„ „ „	1857—1863 =	10·0	„ „ „ „
„ „ „	1864—1873 =	14·8	„ „ „ „
„ „ „	1874—1883 =	17·5	„ „ „ „
„ „ „	1884—1893 =	18·5	„ „ „ „
„ „ „	1894—1903 =	19·8	„ „ „ „
In the year	1903 only =	21	„ „ „ „

This represents an increase of 425 per cent. in the net receipts per acre. No doubt, the price of wood also rose, from 2·1 pence to 4·5 pence per cubic foot, equal to an increase of 114 per cent., or little more than one-fourth of the increase of the net receipts, which is due chiefly to improved management. *These are data referring to the whole of the Saxon State forests, and not to any case specially picked out.* There are forests in the Saxon hills which give more than double the above-mentioned net revenue, growing on land which is not worth five shillings for agricultural purposes. The bulk of the Saxon State forests are stocked with spruce, a species at present so much despised in this country. Surely, similar results could be obtained in this country, if we managed our woodlands as carefully as is the case in Saxony!

After this digression we must return to the subject under consideration. Tables will be found in Volume III. of this Manual showing the yield of forests in Germany, based upon thousands of measurements and referring to various species, such as beech, Scotch pine, spruce and silver fir; also provisional tables for oak, larch and other trees. On numerous occasions British woods have been measured by the author and the results compared with those given in the

tables. In this manner, the yield has been estimated which may be expected from British woodlands if treated systematically and according to correct sylvicultural methods. That yield depends, of course, on the particular class of timber which it is proposed to grow and on the method of treatment, but it would lead too far to give here all possible cases. Hence the simple method of high forest has been selected as applied to larch, ash, Scotch pine, spruce, beech and oak, and the returns determined which they are likely to give if planted on *average* forest land.

It has been assumed that timber of some size is wanted, and that the woods are finally cut over:

In the case of	larch	at the age of			70	years.
„	„	ash	„	„	70	„
„	„	Scotch pine		„	80	„
„	„	spruce		„	90	„
„	„	beech		„	120	„
„	„	oak		„	130	„

These rotations are about the most profitable in the case of high forest. As firewood is at present of little value, it has been left altogether out of the account.

The following returns may safely be counted on in the case of *average* forest land:—

RETURNS OF ONE ACRE OF LARCH WOOD.

Thinning at the age of				Shillings Net in Forest
20 years =	20 cubic feet quarter girth measurement at		6*d.* =	10
Ditto, 30 „ =	130	ditto	7*d.* =	76
Ditto, 40 „ =	330	ditto	8*d.* =	220
Ditto, 50 „ =	360	ditto	9*d.* =	270
Ditto, 60 „ =	360	ditto	10*d.* =	300
Final yield, 70 „ =	3,900	ditto	1*s.* =	3,900

Returns of One Acre of Ash Wood.

Thinning at the age of							Shillings
	30 years	=	60 cubic feet at		10*d.*	=	50
Ditto,	40 ,,	=	150 ,,	,,	1*s.* 0*d.*	=	150
Ditto,	50 ,,	=	220 ,,	,,	1*s.* 2*d.*	=	257
Ditto,	60 ,,	=	270 ,,	,,	1*s.* 4*d.*	=	360
Final yield,	70 ,,	=	2,100 ,,	,,	1*s.* 6*d.*	=	3,150

Returns of One Acre of Scotch Pine Wood.

Thinning at the age of							Shillings
	30 years	=	40 cubic feet at		3*d.*	=	10
Ditto,	40 ,,	=	150 ,,	,,	4*d.*	=	50
Ditto,	50 ,,	=	330 ,,	,,	5*d.*	=	137
Ditto,	60 ,,	=	380 ,,	,,	6*d.*	=	190
Ditto,	70 ,,	=	400 ,,	,,	7*d.*	=	233
Final yield,	80 ,,	=	4,300 ,,	,,	8*d.*	=	2,866

Returns of One Acre of Spruce Wood.

Thinning at the age of							Shillings
	40 years	=	40 cubic feet at		3*d.*	=	10
Ditto,	50 ,,	=	160 ,,	,,	4*d.*	=	53
Ditto,	60 ,,	=	300 ,,	,,	5*d.*	=	125
Ditto,	70 ,,	=	400 ,,	,,	6*d.*	=	200
Ditto,	80 ,,	=	400 ,,	,,	7*d.*	=	233
Final yield,	90 ,,	=	6,300 ,,	,,	8*d.*	=	4,200

Returns of One Acre of Beech Wood.

Thinning at the age of							Shillings.
	40 years	=	50 cubic feet at		6*d.*	=	25
Ditto,	50 ,,	=	100 ,,	,,	7*d.*	=	58
Ditto,	60 ,,	=	280 ,,	,,	8*d.*	=	187
Ditto,	70 ,,	=	350 ,,	,,	9*d.*	=	262
Ditto,	80 ,,	=	400 ,,	,,	10*d.*	=	333

RETURNS OF ONE ACRE OF BEECH WOOD—*continued.*

Thinning at the age of					Shillings
90 years =	460 cubic feet at	11*d.* =	422
Ditto, 100 ,, =	560 ,, ,,	1*s.* =	560
Ditto, 110 ,, =	600 ,, ,,	1*s.* =	600
Final Yield, 120 ,, =	4,000 ,, ,,	1*s.* =	4,000

RETURNS OF ONE ACRE OF OAK WOOD.

Thinning at the age of					Shillings.
40 years =	60 cubic feet at	9*d.* =	45
Ditto, 50 ,, =	150 ,, ,,	10*d.* =	125
Ditto, 60 ,, =	200 ,, ,,	11*d.* =	192
Ditto, 70 ,, =	230 ,, ,,	1*s.* 0*d* =	230
Ditto, 80 ,, =	240 ,, ,,	1*s.* 1*d.* =	260
Ditto, 90 ,, =	250 ,, ,,	1*s.* 2*d.* =	292
Ditto, 100 ,, =	260 ,, ,,	1*s.* 3*d.* =	325
Ditto, 110 ,, =	270 ,, ,,	1*s.* 4*d.* =	360
Ditto, 120 ,, =	270 ,, ,,	1*s.* 5*d.* =	381
Final yield, 130 ,, =	4,070 ,, ,,	1*s.* 6*d.* =	6,105

These data must be considered as moderate in amount More especially the early thinnings are likely to yield more than has been estimated. However, the object is to keep on the safe side and to introduce into the amount the *minima* of returns which may be expected from average land.

We must next deal with the expenses. They are the cost of planting, looking after the plantations, rates and taxes, etc. These items must be estimated on the supposition that a considerable area is planted, say 1,000 acres. Guided by many years' experience, the author found that the planting of mountain and heath land, including the cost of the plants, can on an average be done at the following rates:

	£	*s.*	*d.*
Planting an acre with spruce for	3	10	0
,, ,, ,, ,, Scotch pine ,,	4	0	0

	£	s.	d.
Planting an acre with larch for	4	10	0
,, ,, ,, ,, beech ,,	5	0	0
,, ,, ,, ,, ash ,,	6	0	0
,, ,, ,, ,, oak ,,	6	0	0

The cost of looking after the plantations, including rates and taxes, may be put down at 4*s.* an acre per year all round up to the time when the crop is cut over. Rates and taxes on mountain and heath land, such as is here under consideration, cannot be high, since its letting value is small. It has been shown above that the average return from such land cannot be placed at more than 1*s.* an acre all round. Not all the fifteen million acres of such land are suitable for successful afforestation, but it may safely be said that the suitable part of the land cannot be placed at a higher rental than half-a-crown an acre. At thirty-two years' purchase such land would fetch £4 an acre. If regular fencing is wanted, extra expenditure would be necessary, but on the other hand the plantations will yield an annual shooting rent, and one has been placed against the other by leaving both out of the amount.

And here attention may be drawn to the fact that in operations on a fairly large scale fencing is not nearly so expensive as is sometimes supposed. Assuming that

	£	s.	d.	
To fence 1 acre costs . . .	9	0	0	
,, 4 acres in one block costs .	4	10	0	an acre.
,, 16 ,, ,, ,, .	2	5	0	,,
,, 64 ,, ,, ,, .	1	2	6	,,
,, 256 ,, ,, ,, .	0	11	3	,,

and so on.

To fence small areas here and there, where a considerable extent of land in large blocks is available, means to waste a great deal of money.

Basing the calculation on the data given above it will be

found, that a proprietor will get *compound interest* on his outlay at the rates as shown in the subjoined table:—

Value of Land	Per cent in case the land is planted with—					
	Larch	Ash	Scotch Pine	Spruce	Beech.	Oak
£						
1	5·2	4 6	3 9	3 7	3 3	3 3
2	5 1	4 5	3 8	3 6	3 2	3 2
4	4 8	4 2	3 5	3 4	3 0	3 0
6	4 5	4 0	3 3	3 2	2 9	2 9
8	4 3	3 8	3 2	3 1	2 8	2 8
10	4 1	3 6	3 0	3 0	2 6	2 6
15	3 7	3 3	2 8	2 7	2 4	2·4
20	3 4	3 0	2 6	2 5	2 2	2 2
25	3 2	2·8	2·4	2 3	2 0	2 0
30	3 0	2 6	2·1	2·1	1 8	1·8
35	2 8	2 4				
40	2 6	2 2				
45	2 5	2 1				
50	2 4	1 9				

It has been said in public "that no British landowner will invest money in forestry, unless he is assured 4 per cent. on his money." But, it may be asked, is this reasonable? What other investment of equal security gives 4 per cent. in these days? Does agriculture proper give 4 per cent.? Why should forestry be expected to give a higher per cent. than agriculture? Let us take for a moment the case of British consols; they give, nominally, 2½ per cent., but look at the ups and downs which they undergo! A few years ago they stood at 112, a short time ago they were quoted at 85½, a fall of £26 10*s.* on every hundred, *representing more than ten years' interest.* Imagine what they would fall to, if we were to be involved in another big war! Such fluctuations do not occur in

systematic forestry. Once that industry has been established in an orderly manner, it yields a steady income year after year, and the capital is safe from anything like the fluctuations to which consols are subject. In the author's opinion, forestry conducted on proper lines offers an investment at least as safe as consols, and it seems unreasonable to expect more than 2½ per cent. from it. There are millions of acres in these islands fit for planting which are valued at such a low rate that they can be made, if put under forest, to yield steadily a good deal more than 2½ per cent. At the same time, stress must be laid on the fact that all forest operations must be conducted in a truly economic manner. Extravagance has no place in forestry, nor in agriculture.

The above table shows that, under the given conditions, it pays, as compared with consols, to grow :—

		Per Acre
Larch, if soil of *average* yield capacity does not cost more than	. . .	£45
Ash,	ditto	32
Scotch pine,	ditto	22
Spruce,	ditto	20
Beech,	ditto	12
Oak,	ditto	12

For ordinary mountain and heath land, valued at £4 an acre, the money invested in forestry would yield compound interest in the case of :—

Larch	= 4·8 per cent.
Ash	= 4·2 ,, ,,
Scotch pine	= 3·5 ,, ,,
Spruce	= 3·4 ,, ,,
Beech and oak	= 3·0 ,, ,,

It will be observed that it pays to grow on such land larch, ash (if the soil is suitable), Scotch pine, and even

spruce. As regards beech and oak, the margin is small; hence some further information shall be given regarding oak. Supposing we grow oak on land of a high yield capacity; in that case the following returns may be expected:—

Thinning at the age of					Shillings.
30 years	=	70 cubic feet at		8*d.* =	47
Ditto, 40 ,,	=	200 ,,	,,	9*d.* =	150
Ditto, 50 ,,	=	250 ,,	,,	10*d.* =	208
Ditto, 60 ,,	=	300 ,,	,,	11*d.* =	275
Ditto, 70 ,,	=	320 ,,	,,	1*s.* 0*d.* =	320
Ditto, 80 ,,	=	330 ,,	,,	1*s.* 1*d.* =	357
Ditto, 90 ,,	=	330 ,,	,,	1*s.* 2*d.* =	385
Ditto, 100 ,,	=	330 ,,	,,	1*s.* 3*d.* =	412
Ditto, 110 ,,	=	330 ,,	,,	1*s.* 4*d.* =	440
Ditto, 120 ,,	=	330 ,,	,,	1*s.* 5*d.* =	467
Final yield, 130 ,,	=	6,400 ,,	,,	1*s.* 6*d.* =	9,600

If we make the calculations as before, we obtain the following results:—

Value of Land per Acre £	Per cent.
5	3·5
10	3·2
15	2·9
20	2·7
25	2·6
30	2·5

This shows that it pays to grow oak on really good land valued up to £30 an acre. In other words, land of good quality which lets for more than 15*s.* net an acre is more profitable if used for agriculture than if put under oak.

Before leaving this subject, it will be as well to show the financial results in case not large timber but only poles are wanted—for instance for fencing or pit props. In these cases the treatment differs considerably. Let us suppose we grow

larch, or Scotch pine, or spruce under a rotation of forty years. In that case, we should probably make two thinnings, say at the age of fifteen and twenty-five years in the case of larch, and at twenty and thirty years in the case of Scotch pine and spruce. These thinnings would be heavier than when large clean timber is to be produced.

Supposing we have planted larch on fairly good land and remove the original 2,700 plants as follows:—

Number of poles removed at the age of					15	years	=	1,400
,,	,,	,,	,,	,,	25	,,	=	600
,,	,,	,,	,,	,,	40	,,	=	700
			Total	.	.	.	.	2,700

Then we can count on the following receipts:—

		£	s.	d.
Thinning in the year	15 say . .	10	0	0
,, ,, ,,	25 ,, . .	30	0	0
Final cutting in the year	40 ,, . .	70	0	0

The per cent. on the investment comes out as follows, if the other data remain as before:—

		Per cent.
Cost price of land = £5, interest	. .	= 9
,, ,, = 10 ,,	. .	= 7
,, ,, = 15 ,,	. .	= 5·6
,, ,, = 20 ,,	. .	= 4·8
,, ,, = 25 ,,	. .	= 4·3
,, ,, = 30 ,,	. .	= 3·9
,, ,, = 35 ,,	. .	= 3·6
,, ,, = 40 ,,	. .	= 3·4
,, ,, = 45 ,,	. .	= 3·1
,, ,, = 50 ,,	. .	= 2·9

Supposing now, that the cultivation of larch is undesirable on account of the larch disease, and that Scotch pine and spruce are planted for pit timber. Assuming further,

that we get altogether 3,000 cubic feet of timber at the end of forty years, valued at 6*d.* a cubic foot, and that the thinnings are left out of account, we obtain the following results:—

				Per cent
Cost price of land	=	£1, interest . .		= 5·7
,, ,,	=	2 ,, . .		= 5·3
,, ,,	=	4 ,, . .		= 4·9
,, ,,	=	6 ,, . .		= 4·5
,, ,,	=	8 ,, . .		= 4·2
,, ,,	=	10 ,, . .		= 3·9
,, ,,	=	15 ,, . .		= 3·4
,, ,,	=	20 ,, . .		= 3·0
,, ,,	=	25 ,, . .		= 2·7
,, ,,	=	30 ,, . .		= 2·5

Even in that case the operation pays well, as such land is not likely to cost more than £10 an acre and probably not more than £4 to £6.

Many other examples could be given, but those already recorded will show that, on financial grounds, the afforestation of mountain and heath land rests on a safe basis, provided a proper selection of the land to be afforested is made.

As the author received several enquiries regarding the manner of making calculations like those given above, the details for larch under a rotation of seventy years shall be added as an example.

All calculations must be made with compound interest. Taking the returns for larch given above, as well as the cost of planting, £4 10*s.* and annual expenses, 4*s.*, a number of trial calculations are made with, say, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, and 5 per cent., so as to ascertain the value of the land for larch planting. The formula for doing these calculations will be found in Volume III. of this Manual, third edition, page 124, third line from bottom. One example will show how this formula works, say by calculating with 3 per cent., which

means that all money is taken out of an investment which gives 3 per cent.:—

$$\text{Value of soil} = \frac{3{,}900 + 10 \times (1{\cdot}03)^{50} + 76 \times (1{\cdot}03)^{40} + 220 \times (1{\cdot}03)^{30} + 270 \times (1{\cdot}03)^{20} + 300 \times (1{\cdot}03)^{10} - 90 \times (1{\cdot}03)^{70}}{(1{\cdot}03)^{70} - 1} - \frac{4}{{\cdot}03}$$

If this calculation is carried out, we obtain

Value of soil = 576*s.* = £28 16*s.*

If the calculations with the other per cents. are carried out, we obtain the following:—

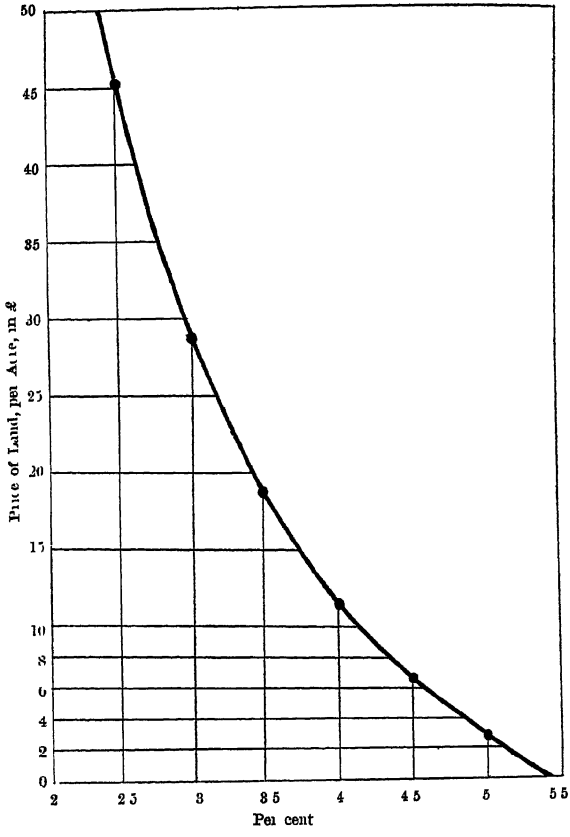
	£	*s.*	*d*
Value of soil calculated with $2\frac{1}{2}$ per cent. =	45	10	0
,, ,, ,, ,, 3 ,, =	28	16	0
,, ,, ,, ,, $3\frac{1}{2}$,, =	18	4	0
,, ,, ,, ,, 4 ,, =	11	1	0
,, ,, ,, ,, $4\frac{1}{2}$,, =	6	3	0
,, ,, ,, ,, 5 ,, =	2	15	0

These values are now plotted with the per cents. as abscissæ and the soil values as ordinates and a curve drawn through them, when the diagram on the next page is obtained.

From this diagram the per cents. yielded under different soil values were read off and entered in the above table for larch. The per cents. for other species were ascertained in the same way.

Enough has been said to show how important the financial aspect of forestry is. This has been recognised in many parts of the world, but not yet sufficiently in Britain. In this country the importance of natural history, and more particularly botany, has up to date held the field, while the financial or mathematical aspect of the forest industry has been overlooked. No doubt, a forester must be a good sylviculturist, and to be that, he requires to have a fair knowledge of botany, geology, and entomology, but that alone will not make him a competent forester.

To be the latter, he must also have a fair amount of mathematical training. This branch of a forester's education is in no way of less importance than the study of natural history, which has, up to date, only too often been mistaken for the



only basis of forestry by specialists who had not succeeded in grasping the true objects aimed at by the forest industry conducted on economic lines. These matters must be fully borne in mind when arranging for the instruction in forestry in this country. Then, a sound understanding of the

essential points of the industry will spread, and thus render landed proprietors more and more inclined to put their waste lands to more profitable use than has been the case in the past. No doubt, the British landed proprietor does not like investing money in an undertaking which, in the nature of things, cannot be expected to yield a return for a number of years At the same time, if he becomes convinced that his money will bring him or his children a fair, even if delayed, interest, and that the investment is a secure one, he will not hesitate to make it.

Section IV.—Notes on Some Types of British Woodlands.

In the previous pages the afforestation of additional areas has been dealt with, and it has been shown that a fair interest on the invested capital may safely be expected. The author cannot close this volume without offering a few remarks on the subject of improving the returns from some of the existing woodlands. As already stated, the management of these woods is subject to special demands on the part of the proprietor which frequently reduce the income; nevertheless, the latter can be considerably increased, if the management is more systematised in the manner now to be indicated.

1. *The Treatment of Game Preserves.*

British woods consisting of broad-leaved species are used as game preserves, especially for the rearing of pheasants, and the latter object is, in the majority of cases, paramount. On most estates, the gamekeeper's duties are entirely separate from those of the woodman, and in only too many cases the two men prosecute different objects.

If antagonism has hitherto existed between the two officials of an estate, it is, at any rate in many cases, just as much the fault of the forester as of the gamekeeper, because the former has not succeeded in managing the woods in such a manner that they lend themselves to the preservation of game and yet

yield an adequate revenue from timber and firewood. As matters are in Britain, it is no use crying out against game, because proprietors, rare cases excepted, will not adopt an economic management of their woods, if game is interfered with to any considerable extent. It is the business of the forester to manage the woodlands in such manner that they meet the objects which the proprietor has in view to the fullest extent and in the most economic manner. The preservation of game being in most cases an important object, the forester must set to work to meet it, without reducing the yield of the woods more than is absolutely unavoidable. There is no reason whatever why both objects should not be obtained, without perpetual warfare between the gamekeeper and the forester. Indeed, there are good reasons why the two offices should be in one hand, since it rests at all times with the proprietor to decide, whether the one or other object shall take precedence. What the exact method of treatment should be, cannot be laid down in a general way; it depends on local conditions, the kind of game to be preserved and on the extent to which one object is to be sacrificed to the other. Hence, only concrete examples can illustrate how such cases should be dealt with. On this occasion it is proposed to deal with the sylvicultural treatment of pheasant preserves.

Pheasants can be reared in woods managed under any sylvicultural system, but it is generally recognised that those systems are best adapted, which provide an underwood worked as coppice and an overwood worked as high forest. The question then is, how should such woods be managed, so that they favour a plentiful and healthy stock of pheasants and yet yield a commensurate income by the sale of timber and other wood. Both objects can be attained by treating such woods under the system known as "coppice with standards" according to an orderly and systematically-arranged plan of operations, or, as foresters call it, a working plan. The necessary conditions may shortly be indicated as follows :—

(1.) A full and dense underwood is essential, at any rate over the greater part of the area. This can be maintained only by cutting it over periodically and protecting the new shoots for some years against ground game. If the underwood is allowed to grow too old, it becomes thin below and no longer fulfils its purpose as regards the game. Again, if not protected against ground game, the new shoots are cut back, or seriously injured, and they become weak and are deficient in giving shelter. Again, if the stools are too old, they will not send forth vigorous fresh shoots when cut over.

(2.) The overwood must be sufficiently thin to admit the required amount of light to the underwood, without which the latter cannot thrive. To meet this requirement, it is necessary that the overwood should consist of thin-crowned species, such as ash, oak, larch, birch, poplar and perhaps pines, and the underwood of species which are either shade-bearers, or which at any rate can stand a moderate amount of shade. Of broad-leaved shade-bearers, which alone can come into consideration in the case of coppice, beech stands first and hornbeam next. These species, however, are not very remunerative, and in the majority of cases others which are more so must be chosen. Among these, ash stands first and hazel perhaps next. Ash demands a fair amount of light, but it is well known that it will thrive, provided the overwood is constituted as indicated above. Alder is useful in wet places and chestnut on sandy soils. Other species may be added to the underwood to meet special requirements.

(3.) The third essential condition is that game preserves should be disturbed as little as possible. If forest operations are conducted in them, it must be done at a certain season of the year, say before March and, if possible, at a few years' interval.

The question then arises, how can all these requirements be made to fit in? This it is proposed to show on an example. Let it be assumed that a proprietor has an area of 200 acres in one block, or in a number of blocks, say four of fifty acres

each, or one of 100 acres and two of fifty acres each, or any other combination, the soil and situation being suitable for the growth of oak, ash and larch.

Determination of the Rotation of the Underwood.—The first point to decide is what age the underwood is to reach. The answer depends, of course, on local conditions. In some cases the underwood is cut at the age of ten years, in others at twelve, fifteen, twenty, or more years. In the High Meadow woods it has been decided to cut it at thirty-five years. This is a somewhat high age, but it has been adopted chiefly because at that age the underwood yields material fit for pit-timber. Short rotations of the underwood have the important disadvantage that the overwood will develop strong branches low down and yield stems clear of branches only to a moderate height, but the advantage that stools will send up vigorous coppice shoots. Long rotations of the underwood have the advantage that the overwood or standards will have boles clear of branches to a considerable height and thus yield timber of high value, but the disadvantage that a certain portion of the stools will send up either feeble shoots or none at all. A middle course is probably best. If the underwood consists chiefly of ash, with an admixture of hazel, the rotation of it might be fixed, on fairly good land, at twenty to twenty-five years, according to local conditions. In this way, the standards of oak and ash can be kept clear of branches to a height of about thirty feet. Let us say, for the sake of illustration, that twenty years has been chosen.

To show the favourable effect of a fairly long rotation of the underwood upon the shape of the standards, attention is invited to the appended illustration of a coppice with standards wood in the Prince d'Arenberg's forest near Valenciennes. The rotation of the underwood is twenty-five years.

Division of Area into Annual Coupes.—The second step is to arrange the woods into twenty coupes, or cutting areas, of approximately equal extent and to deal with one coupe in each year. In our example that coupe would be equal to $200 \div 20 = 10$

Coppice with *Oak* Standards, near Valenciennes, on the estate of the Prince d'Arenberg

The underwood, 25 years old, was cut during the previous winter.

(From a photograph taken by E V Ellis, Indian Forest Service)

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acres. If more convenient, the area may be divided into forty coupes of five acres each, of which two are dealt with in each year. If the total area of woods is very large, there would be two, three, or more series, each containing twenty coupes. The important point is the distribution of the coupes in each series of twenty which requires to be explained. Let us assume a simple case, say there are four blocks of fifty acres each, so that there would be five coupes in each block. At the outset, the growing stock in already existing woods, in all probability, would be more or less irregular, but it should be laid down as a rule that cuttings in each block should be made only once in every four years. In this way, each block will enjoy absolute rest for three years, and at the end of the first twenty years the ages of the underwood should be as follows .—

BLOCK I.

Coupe 1 should have underwood = 20 years old.
„ 5 „ „ „ = 16 „ „
„ 9 „ „ „ = 12 „ „
„ 13 „ „ „ = 8 „ „
„ 17 „ „ „ = 4 „ „

BLOCK II.

Coupe 2 should have underwood = 19 years old.
„ 6 „ „ „ = 15 „ „
„ 10 „ „ „ = 11 „ „
„ 14 „ „ „ = 7 „ „
„ 18 „ „ „ = 3 „ „

BLOCK III.

Coupe 3 should have underwood = 18 years old.
„ 7 „ „ „ = 14 „ „
„ 11 „ „ „ = 10 „ „
„ 15 „ „ „ = 6 „ „
„ 19 „ „ „ = 2 „ „

BLOCK IV.

Coupe 4 should have underwood = 17 years old.

,,	8	,,	,,	,,	= 13	,,	,,
,,	12	,,	,,	,,	= 9	,,	,,
,,	16	,,	,,	,,	= 5	,,	,,
,,	20	,,	,,	,,	= 1	,,	,,

The following diagram will further illustrate this :—

Number of Coupe, or Year when it will be Cut in Each Rotation of 20 Years.

No	17	13	9	5	1		18	14	10	6	2
WEST		Block I.				Ride		Block II.			EAST
Age	4	8	12	16	20		3	7	11	15	19
	Ride.						Ride				
No.	19	15	11	7	3		20	16	12	8	4
WEST		Block III				Ride		Block IV			EAST
Age	2	6	10	14	18		1	5	9	13	17

Age of Wood at the Commencement of each Rotation

In this way, each block of the wood will contain young, middle-aged and old coppice, and have three years' complete rest. Whenever it is practicable, the coupes should be so arranged that the cuttings proceed against the prevailing wind direction, leaving a shelter-belt on the east and north edges of the wood against cold winds.

Number and Distribution of Standards.—The third question to be decided is the number and distribution of the standards. The number depends, of course, on the quality of the locality, the species and the size of timber which it is proposed to

grow. Under any circumstances, the ages of the standards must be multiples of the rotation of the underwood whenever cutting comes round; that is to say, in our example coupe No. 1 would contain standards aged 20, 40, 60, 80, 100 . . . years old, of which the youngest form part of the underwood, until cutting has actually taken place.

The number of standards in the several age-classes must form a falling series, in other words, there must be more standards in the twenty years old class than in the forty years class, and so on to the oldest class which would contain only a few trees per acre. It is, of course, out of the question to work up exactly to the theoretically determined number in each class. Hence such figures can only serve as a general guide. *By way of illustration*, the following example will show the numbers before and after cutting and the difference, representing the number of trees removed at each cutting, assuming that the oldest trees shall reach the age of 100 years.

NUMBER OF STANDARDS IMMEDIATELY BEFORE CUTTING.

Age of Trees.	Oak.	Ash, Larch, etc.	Total.
New standards, still forming part of the underwood, say . . .	25	25	50
Standards 40 years old . . .	25	25	50
„ 60 years old . . .	15	15	30
„ 80 years old . . .	5	10	15
„ 100 years old	5	...	5
Total	75	75	150

NUMBER OF STANDARDS IMMEDIATELY AFTER CUTTING

Age of Trees	Oak.	Ash, Larch, etc	Total.
Standards just selected from underwood, 20 years old	25	25	50
Standards, 40 years old .	15	15	30
„ 60 years old .	5	10	15
„ 80 years old	5	...	5
Total .	50	50	100

STANDARDS CUT

Age of Trees	Oak	Ash, Larch etc	Total
Standards 40 years old	10	10	20
,, 60 years old	10	5	15
,, 80 years old		10	10
,, 100 years old	5		5
Total	25	25	50

In this example it has been assumed that ash, larch, etc., disappear at the age of eighty years, oak only being allowed to reach a higher age. Any other suitable combination may, of course, be adopted; for instance, some of the eighty-year-old oaks may be cut out, or specially fine oaks may be allowed to grow beyond the age of 100 years. In such cases, the other figures must be modified accordingly. It is, under any circumstances, necessary to begin with a large number of young standards per acre, to guard against accidents, and because not all will develop into fine timber trees. In selecting the twenty-year-old standards, or tellers, the finest specimens are chosen, and these reduced step by step, allowing only the most promising trees to reach maturity. In this way, timber of various dimensions is obtained at every cutting. It goes without saying that in addition to oak, ash and larch any other suitable species may be introduced, as, for instance, spruce, a few specimens of which are very desirable in pheasant preserves. The distribution of the standards over the area should be such that each coupe contains about the same number with the proper proportion in the age classes. In some cases, the standards are arranged by single trees, each separated from its neighbour; in others, they stand in small groups.

The system of placing the standards into moderate sized groups can specially be recommended, because:

(1.) far more valuable timber trees are produced, as the standards draw each other up; and,

(2.) woods so arranged are just what pheasants like; a dense underwood, over which groups of trees (standards) are scattered. In this case, the age classes of the standards form separate groups. The area occupied by the underwood on the one hand and the standards (or patches of high forest) on the other, depends on circumstances and more particularly on the objects which the proprietor has in view.

Procedure to be followed at each Cutting.—When the underwood has reached the desired age, in our case twenty years, the first business to be attended to is the selection of the new standards, in our example twenty-five oaks and twenty-five ash and larch, or any other species which may be desired. It is essential to select, in the first instance, more than this number, as some may be injured by the subsequent fall of the standards. Then the rest of the underwood is cut. The next step is to cut the standards which are to come down. As soon as the material has been removed, the area must be examined for seedling plants of the desired species. If a sufficient number is found, no planting will be required; but if this is not the case, all vacant spaces must be filled up with healthy, vigorous plants, or new groups of standards started. It is impossible to say how many plants may be required, but in the majority of cases 400 per acre will suffice, even if no natural seedlings at all are found. Of these, about 100 should be oak and 300 chiefly ash, with a moderate number of larch and other desirable kinds. These will grow for twenty years, when the fifty best will be left as new standards, and the others, oak, ash and other hardwoods, are cut over to produce new stools for coppice in the place of those which have died or are too old to produce vigorous shoots. The final step is to go over the coupes cut four, eight, twelve and sixteen years ago, to free the plants from threatening stool-shoots and perhaps thin out the shoots where there are too many on one stool.

In order to give sufficient time for all these operations, it

should be arranged that the wood, or block (in our example one out of four), where forest work is to be done in any one year, should be shot over early in the season, so that the work may be commenced not later than December 1st and be completed by March. In this way the forest operations will not interfere with the shooting, so that both objects can be fully realised.

2. *Conversion of Coppice Woods into High Forest.*

There was a time when coppice woods yielded such high returns that this method of treatment was doubtless the most profitable which could be adopted. Now, however, matters have changed. Oak bark has fallen in value to such an extent that the surplus of the sale value over the cost of peeling and preparing the bark has become very small. Not long ago the author had to do with an extensive area of oak coppice woods in the south of England, which had given of late years, after deducting the cost of cutting, peeling, etc., an income of about four shillings an acre annually. Taking into consideration the cost of administration, rates, taxes, etc., these lands give practically no income at all. Nor is oak bark likely to rise again in price. There is not only an ever-increasing import of foreign tanning materials, but it is almost certain that before long tanning will be done chiefly with artificially prepared agents. Hence one class of coppice woods is financially lost. Matters are even worse as regards other coppice woods. Where ash can be grown, fair financial results may still be obtained, and in certain localities hazel and chestnut sell as yet; but taking coppice woods as a whole, their value has fallen so much that in many cases the produce is actually unsaleable; hence the time has arrived to consider their position in rural economy. In some cases, as in game preserves, coppice in combination with standards may still be indicated, but in all other cases coppice woods should be

converted into high forests, whenever the proprietor looks forward to the realisation of reasonable returns from his woodlands.

When conversion has been decided on, the simplest plan is to carry it through step by step, as the coppice in each section of the wood reaches the most profitable age. As soon as the coppice has been cut, it should be interplanted with suitable timber trees, the plants being placed between the stools. They will grow up with the fresh stool-shoots, the latter providing shelter to the soil and drawing the seedling plants up. As the shoots are likely to grow at first quicker than the seedling plants, the area must be gone over repeatedly and the plants freed from interfering stool-shoots. During these operations only so much of the shoots should be cut away as is absolutely necessary for the benefit of the plants, the rest being left to protect the soil. Subsequently, one of two plans may be followed: if the height-growth of the seedling plants is sufficiently rapid to outstrip the coppice shoots after some time, the two may be allowed to grow on together. If, on the other hand, the coppice outstrips the seedling trees for a lengthened period of time, then it may be cut over once more, and the subsequent shoots will assume the character of an underwood.

The question what trees to plant is of the first importance. The selection depends, as in all such cases, on the special conditions of each locality; but the following remarks may prove useful. In the majority of cases, fast-growing species are indicated, such as larch, ash, Douglas fir and various pines, say Scotch, Corsican and Weymouth. The first three should be planted only on fairly good soil and in otherwise suitable localities. Larch, particularly, should not be planted, if the disease is prevalent in the locality and under any circumstances only on cool aspects. Ash requires a sufficient quantity of moisture in the soil while Douglas fir is partial to sheltered positions. In warm localities and on indifferent soil the three pines are indicated. As regards oak, sycamore

and similar timber trees, they can be recommended only in the case of really fertile lands, and then the stool-shoots must be periodically reduced in size and height, until the seedling plants, especially the oak, can hold their own against the coppice.

When interplanting coppice woods it is essential that the plants should be given the best possible chance of holding their own against the stool shoots; hence vigorous plants with a well developed root system should be chosen, and they should be planted into pits. None of that barbarous system called notching, under which the roots are all pushed to one side.

A few words about silver fir and spruce. In many cases these species may be planted in coppice woods. They stand much shade, especially the silver fir, and when they have once commenced to go ahead, they will speedily overtop the coppice shoots. The author has, since 1894, planted spruce in coppice on an area of 2,000 acres, so far with complete success. He has found the cost of going over the areas, to help the spruce against the coppice shoots, very small, and in plantations seven years old the spruce does not require any further help. The value of spruce timber in Britain is at present small, but if the trees are grown in fully stocked woods, they will produce timber of a high quality, because the annual rings will be narrower and the stems free of branches to a good height. As to quantity, spruce is a good producer; on soil of fair quality, 100 cubic feet, according to quarter-girth measurement, per acre and year may safely be relied on. The author has a spruce wood forty years old, situated on a rather steep south-eastern slope, the underlying rock being clay-slate, at an elevation of 1,100 feet above the sea, which has produced 127 cubic feet quarter-girth measurement per acre and year. Such woods will pay a fair rate of interest on the capital invested in them, apart from any rise in the price of timber in the future.

3. *The Production of High-Class Oak, Ash and Larch Timber.*

Firewood being of small value in Britain, timber trees should be reared in such a manner that they yield the highest possible percentage of high-class timber and a correspondingly small quantity of wood which is only fit for fuel. In this respect the above-mentioned three species differ very considerably. Larch produces naturally a high percentage of timber; oak, on the other hand, will spread out horizontally, if not prevented from doing so, producing a short stem and large head and yield only a poor percentage of timber accompanied by a high proportion of firewood. Ash stands between larch and oak in this respect; and yet the rearing of these three species has much in common. All are light-demanding, especially the larch; all are thin-crowned, and none of them improves the yield capacity of the locality if raised in pure woods. The best way of rearing them is to mix them with a shade-bearing, full-crowned species. Of these, beech is the best. In mixture with beech, the above-mentioned three timber trees find all the advantages of a permanent and complete shading of the ground, a heavy fall of leaves followed by a thick layer of humus and freshness of the soil throughout summer. The competing beech forces the other species to push upwards, kills off their lower branches and causes them to produce long, straight, clean boles of high value. Woods of this kind require, however, the careful attention of the forester, especially in the case of the oak.

Oak and beech stand sufficiently near each other as regards their demands on the locality. No doubt oak prefers a somewhat moister soil than beech, but the latter accommodates itself to the former; as a matter of fact, they are growing and thriving together over extensive areas. The principal difficulty to contend with is their relative height-growth. In some localities the oak keeps pace with the beech, but in the majority of cases the latter is faster growing after the first few

years and, if unchecked, kills out the oak. In the former case, the oak can be mixed singly into beech woods, care being taken in the thinnings to help the oak whenever necessary. In the second and much more frequent case, the oak must either be given a considerable start of the beech, or grouped together, or both.

For the purpose of giving the oak a start it may be grown pure in the first instance. It will fairly shelter the ground until it begins to thin out, which generally occurs, according to local conditions, between the age of thirty to sixty years. Up to that age, the wood should be kept dense, so that tall, clean stems may be produced. About the age of forty somewhat heavier thinnings should commence, giving gradually more growing space to the more promising oaks. Then a specially heavy thinning should be made and the area under-planted or sown with beech. The young beech are very grateful for the shelter of the oaks during several years. Then more thinnings may take place, leaving the most promising oaks in such numbers that the beech below them has sufficient light to come up. Both crops are then allowed to run through a full rotation, favouring at all future thinnings the development of the oak. In this way a crop of mature oak and beech is obtained, the age of the former being some fifty years more than that of the beech. This method of growing mixed oak and beech is shown in the accompanying four illustrations.

The second method of rearing oak with beech is to place the former in groups, surrounded and separated from each other by beech. For the oak, the most favourable spots should be selected, where the soil is deep and the aspect favourable, especially south-east or south. These spots should be sown with acorns, or densely planted with young oak plants one year old, about 8,000 to the acre. As soon as they are well established, the remaining parts of the wood should be stocked with young beech, either naturally or artificially according to circumstances. The size of the oak groups should not vary much. If they are too small, the beech does much damage

Oak Regeneration 3 Years Old, Started by Sowing Acorns under a Thin Shelter-wood

(From a photograph by W F Perrée, Indian Forest Service)

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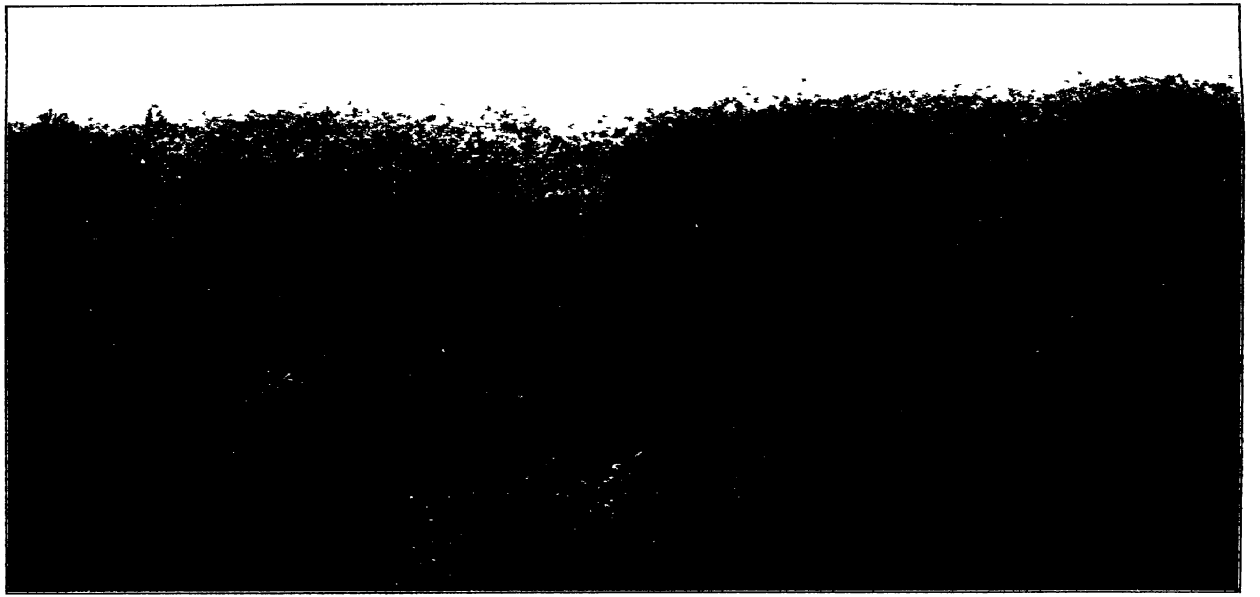

Oak Wood 10 Years Old, Started by Sowing Acorns under a Shelter-wood, which was Removed Three Years ago (Spessart)

(From a photograph by F McClellan now Professor of Forestry at the Royal Agricultural College, Cirencester)

Oak, underplanted with *Beech* in Nassau
(From a photograph, taken in winter, by R. E. Marsden, Indian Forest Service.)

Sessile *Oak*, grown with Beech and Hornbeam, Forest of Bellême, France

This Oak was left standing when the wood was cut down, to show the fine dimensions of the Oak in this wood

Girth = 9′ 9″ Height = 119 feet Volume = 355 cubic feet, quarter girth measurement

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along the edges; if too large, the advantages of the admixture of beech are considerably reduced. Hence, the area of the oak groups should lie between one quarter of an acre and one acre. In the natural course of events, the beech will commence to intrude into the oak groups, as soon as they begin to thin out above, thus establishing an underwood of beech in them. If the beech does not come naturally into the oak groups, it may be artificially introduced by sowing or planting. In this way, again, fine oak can be produced, and the increment per acre can be kept at the highest possible rate.

Instead of beech, the silver fir has been used for underplanting oak woods, a method which has given very good results. In somewhat moist places, hornbeam has taken the place of the beech. Spruce has also been used, but it is not so good as the others, as the oak is liable to become stag-headed; the mixture is admissible under favourable conditions, or where the spruce is to be cut out at a comparatively early age. Oak has also been underplanted with Weymouth pine and with fairly good results.

The rearing of *ash and beech* in mixture can be done as in the case of oak and beech. The ash is either grown pure and subsequently, at the age of twenty to thirty years, underplanted with beech; or the two are started at the same time. In the subsequent thinnings, the ash is duly protected against any attacks on the part of the beech. Frequently, ash and oak are planted together, mixed, and subsequently underplanted with beech or silver fir.

The rearing of *larch with beech* is of special importance, now that the larch disease has spread over the length and breadth of Britain. Whatever the cause of the disease may be, suffice it to say that its rapid spreading is due to the indiscriminate planting of pure larch, especially in localities which are not thoroughly suited to the species. It is now recognised in Britain that larch should be planted only in favourable localities; that is to say, in a fairly rich soil and on cool aspects. Even then, the formation of pure larch woods is

dangerous, because if the disease breaks out it will rapidly spread over the whole wood. Hence larch in moderate quantity should be mixed with another species which, as it were, separates the individual larch trees. None is better than beech. Here the larch has its best chance. The procedure is to plant a limited number of vigorous larch plants among beech and let them grow up together, protecting the former sufficiently during the thinnings, as it requires to have its head freely exposed to sun and air.

Another method is to grow larch pure, to thin it out heavily between the ages of fifteen and twenty-five years, and to underplant it with beech. Of the larch, only the best stems are left to grow into timber trees.

Unfortunately, very extensive areas of young pure larch woods are found in Britain. Only a few years ago the forester of a large landed proprietor in the Midlands appealed to the author for advice, what to do with some 2,000 acres of young larch which were frightfully diseased Cases like this are very sad, and the only chance of saving some of the trees as yet unattacked is to cut out as quickly as possible all diseased larches and to underplant with beech, thus preserving healthy conditions for the further development of the remaining trees. Instead of beech, such woods may be underplanted with silver fir or spruce, whenever the latter are likely to give better financial results. Douglas fir has also been tried and ought to do well, since the remaining larches will give it just that shelter which the leading shoots of the Douglas fir so much require. Even Weymouth pine may be used for this purpose. The author has under-planted Scotch pine with that tree, and the results are everything that can be desired. If the Weymouth pine does well under Scotch pine, it will do still better under larch, as that tree gives a lighter cover than the Scotch pine. Mr. Munro Ferguson, the pioneer of rational forestry in Scotland, has, at Novar, underplanted larch at the age of sixteen to twenty years with Douglas fir, *Tsuga Mertensiana, Thuja gigantea, Cupressus Lawsoniana,*

Scotch Pine with a *Beech* Underwood
Scotch Pine, 70 years old Beech 12 years old.
(From a photograph by R E Marsden, Indian Forest Service

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Abies grandis and *Picea Sitchensis* with marked success. He raises the larch pure, and cuts out all diseased trees before underplanting, leaving from 300 to 500 of the best larch.

On the Continent, the Scotch pine is also underplanted with beech, as the accompanying illustration will show. In this way, the finest Scotch pine is produced worth a shilling a foot and more.

4. *The Forest of Dean: An Object Lesson.*

In the previous paragraphs on The Production of High-class Oak, Ash and Larch Timber, special attention has been drawn to the importance of raising these light-demanding and thin-crowned timber-trees in mixture with a full-crowned, shade-bearing species, such as beech or silver fir. This method of rearing valuable trees has for its principal object to secure a continued fertility of the soil. As some readers may raise the cry of "theoretical speculation"—a cry so frequently heard, when people do not understand a subject, or do not care to face the inconvenience of a new departure—it will be useful to fortify what has been said by producing an example in point. It is, alas! a negative example, but it will serve its purpose. The example is the "Forest of Dean."

Any person with a pair of eyes, who visited the Dean ten or twelve years ago and made his way across the several woods, found on by far the greater part of the area a thin crop of oaks from eighty to ninety years old of poor height growth, with rounded or flat tops and the branches coming down low, so that only clear boles of small length were formed. Looking down on the ground, our observer would see the soil covered with a matting of grass and weeds, overrun with brambles, etc. Presently, the wanderer would probably come across a solitary old oak or two of magnificent dimensions, towering high over the eighty to ninety years old crop; the idea would at once cross his mind that the flat-topped younger generation could never grow to the height of the few remaining old trees, and he would be sure to ask "What has brought about this change?" The answer is,

"The nineteenth-century foresters in charge of the Dean have ruined the former fertility of the soil by trying to grow oak pure beyond youth, by excessive thinning and by unrestricted grazing."

An inquiry into the past history of the forest has revealed the fact that, up to the end of the eighteenth century, the Dean carried a mixed crop of oak and beech in the proportion of one oak to about two beeches; under these conditions the fine oaks of enormous size were produced, which made the forest renowned and provided large quantities of first-class timber for the "walls of oak of Old England."

This fine crop of timber was cut early in the nineteenth century, with the exception of about 500 acres which were cut in 1852—1853, yielding an average of 154 cubic feet of timber per tree according to quarter-girth measurement. The cleared areas were replanted, so that most of these woods are now about ninety years old and the rest forty to fifty years. As far as is known, oak was planted with nurses, the latter having been cut out subsequently. And then the disastrous treatment commenced. When the woods had reached the age of thirty or forty years, they were considered safe against cattle and the greater part of the enclosures were thrown open, especially to extensive sheep grazing. About the same time it was considered the correct thing to thin heavily, and this was done during a number of years, until the trees were practically isolated. What the result of these operations is, has already been indicated. The soil, exposed to the unrestricted action of sun and air currents, became in most parts practically unproductive, the result being a very inferior crop of unpromising oaks, short in height and branched low down. How different might have been the results, if, instead of throwing open the enclosures and making injudicious thinnings, the oak had been underplanted with beech at the age of thirty to fifty years, thus keeping the soil under constant protection and causing a gradual accumulation of fertile leaf-mould on the soil.

It is due to Mr. Stafford Howard, Commissioner of Woods, and Mr. P. Baylis, Deputy Surveyor, Forest of Dean, to say that they recognised the unsatisfactory state of things and set to work some twelve years ago to mend matters. There were, however, great difficulties in the way. In the first place, the areas, so ruthlessly thrown open, had to be re-enclosed, and this could be done only gradually; however, good progress has already been made, and it is believed that the whole area of 11,000 acres allowed by law has once more been brought under proper control. In the second place, the authorities had to consider what to do with the existing woods. In consultation with the late Mr. Hill, of the Indian Forest Department, they decided to underplant with beech the limited area of woods under fifty years old, where the mischief could still be remedied, as quickly as the occurrence of beechmast years permits. The older oak woods, about ninety years old, demand a somewhat different treatment, and this was commenced by Mr. Baylis about ten years ago. In these woods only oaks of some promise are left, all others being cut out; then all blanks are filled up, chiefly with larch, oak and other trees, such as sycamore and ash, and in certain places spruce and Douglas fir. As soon as these young plantations have made a fair start, beech will be brought in over the whole area, so as to return to a state of affairs similar to that which existed a hundred years ago.

Some authors have of late been writing about "The New Forestry." Alas! it seems what is really wanted is to return to "The Old Forestry," and to eliminate as quickly as possible the errors introduced into British forestry by the nineteenth century forest experts. These gentlemen were in too much of a hurry. "Quick returns regardless of consequences" was their maxim, and now they have almost ruined national property of an enormous value, inasmuch as they have considerably reduced the fertility, or yield capacity, of the soil. It may indeed be said that the competency of a forester can be judged by examining the soil in his forests: if there is a

good layer of leaf-mould on the ground, the management is sure to have been good; if not, undoubted mistakes have been made which should be eliminated as quickly as possible.

No doubt, some readers will say, this is all very well, but what are we to do with so much beech which fetches only a small price per cubic foot? The answer may be given by another question:—What is done with beech in Buckinghamshire and adjoining counties? Why, it is made into chairs, other articles of furniture and tools, and it fetches at least a shilling a foot all round. In other words, *provide the raw material and industries to utilise it will soon spring up. They follow the raw material* Beechwood is coming into use more and more every year, for casks for dry goods, railway sleepers, pattens, heels for ladies' boots and what not. Besides, the beech need not occupy more than half the crop, or it may be kept almost wholly below the oak.

Let us hope that the twentieth century foresters will profit by the lesson and revert to methods of treatment, which will secure the continued yield capacity of the soil and thus lead to returns far higher than those, which have been obtained of late from extensive woodlands in these islands.

SUMMARY.

In summing up the position as regards the progress made in introducing systematic and economic forestry into the British Empire, it may be said that only India has definitely and satisfactorily grappled with the forest question, that South Africa and the Straits Settlements are on the right path, that some of the other colonies, like Ceylon and various parts of Africa, are doing something, but that Canada and Australia are much behindhand. And yet the two last mentioned are the two countries which are best capable of providing the great quantity of imports into the Empire of timber of general utility. These have now risen to a value of £22,000,000 a year, and the annual increase of imports has, of late years, amounted to about £1,000,000. Apart from the fact that supplies from foreign countries will fail us as time goes on, would it not be wise to keep this large sum of money in the Empire thus providing a considerable amount of extra work?

Surely the time has come, or rather it came some time ago, for a more vigorous forest policy on rational lines throughout the Empire. The question is, no doubt, beset by great difficulties, but where there is a will there is also a way. Above all, let Canada and Australasia consider a little more seriously than up to date the splendid example set to them by India, where, in spite of equally great difficulties, the preservation of the State forests has been placed on a safe basis for the everlasting benefit of the people of that country and of the Indian Exchequer.

APPENDIX.

PROGRESS OF FORESTRY IN THE UNITED STATES.

While this volume was passing through the press, the Report of the Secretary of Agriculture, United States of America, for the year 1905 came to hand. With Mr. Secretary Wilson's sanction, the following extracts from the Report are added. They will, no doubt, be found interesting and instructive:—

"Forest Service.

During the past year the Government work in forestry entered a new phase. Practical work in the actual introduction of forestry began in 1898, but it was not until February 1, 1905, when the care of the National forest reserves was transferred to the Department of Agriculture, that the Forest Service became an administrative organisation.

This transfer was a logical outcome of the recent work of the Service. During the last six or seven years it has passed through a remarkable development, which has followed but not kept pace with its demonstration of capacity for public usefulness. On July 1, 1898, the Division of Forestry employed eleven persons, of whom six filled clerical or other subordinate positions, and five belonged to the scientific staff. Of the latter, two were professional foresters. The Division possessed no field equipment; practically all of its work was office work.

At the opening of the present fiscal year the employees of the Forest Service numbered 821, of whom 153 were professional trained foresters. Field work was going on in 27

States and Territories, from the Atlantic to the Pacific and from Canada to Mexico. Over 900,000 acres of private forest were under management recommended by the Service, and applications on file for advice from owners contemplating management covered 2,000,000 acres more. During the year nearly 62,000 letters were sent out from the offices at Washington, the majority of them in reply to requests for information and advice from the public, of a kind which could not be met by printed information.

This contrast imperfectly indicates the full extent of the change which has taken place, and the progress which has been made. Seven years ago there were in the whole United States less than ten professional foresters. Neither a science nor a literature of American forestry was in existence, nor could an education in the subject be obtained in this country. Systematic forestry was in operation on the estate of a single owner, honorably desirous of furnishing an object lesson in an unknown field. Lumbermen and forest owners were sceptical of the success of forest management, and largely hostile to its introduction. Among the public at large a feeling in favour of forest preservation, largely on sentimental grounds, was fairly widespread, but almost wholly misinformed. It confounded use with destruction, shade-tree planting with forestry.

The real need of forestry was urgent. A time had come which presented at once a great opportunity and a dangerous crisis. Forest destruction had reached a point where sagacious men—most of all, sagacious lumbermen—could plainly discern the not distant end. The lumber industry, vital to the nation at large, was rushing to its own extinction, yet with no avenue of escape apparent until forest management for future crops should be forced by famine prices. Meanwhile, however, the ruin would have been wrought already.

Timber-land owners were selling their holdings or their stumpage with little evidence of an understanding of their

future value, and lumbermen were compelled by business competition to keep down the cost of operation to the lowest terms or market their product at a loss.

Forestry was both an evident economic need and an apparent economic impossibility. Few well-informed persons believed that the obstacles to its introduction could be overcome sufficiently to bring it into common practice among private owners during the lives of the present generation.

That the whole situation is profoundly altered is directly and chiefly due to the work of the Forest Service. With its offer of practical assistance to forest owners made in the fall of 1898, its field of action shifted from the desk to the woods. The lumberman was met on his own ground. Uncertain speculations were converted into business propositions and untried theories into practical rules. Actual management for purely commercial ends has been taken up and applied on their own holdings by some of the best known lumbermen in the country. What lumbermen as a body now think of forestry is illustrated by the recent effective movement in their National association to endow a chair of lumbering at one of the forest schools.

Public opinion generally has experienced an equal change, and a sound National sentiment has been created. The great and varied interests dependent upon the forest have been awakened to the urgent need of making provision for the future. States have been led to enact wise laws and enter upon a well-considered forest policy.

Forestry is a matter of immediate interest to every household in the land. Forest destruction is no imaginary danger of a distant future. If it is not speedily checked its effects will sooner or later be felt in every industry and every home. To make these facts known is a National duty. The work of education must continue until public opinion will not tolerate heedless waste or injudicious laws.

Present Standing of Forestry.

The period which has passed since 1898 has been, in forest work, a period of large definite accomplishments and of effective preparation for the future. Commercial tree studies looking toward management have been prosecuted for 32 important species. Working plans have been prepared in 28 States, and field work has been conducted in every State and Territory in the United States, and in Porto Rico, Alaska, and the Philippines.

The scientific knowledge gathered in the field has taken form in a rapidly growing literature on the subject, and has furnished the basis for a system of professional education. To-day there is scarcely more occasion for the American to go abroad to study forestry than to study medicine or law.

In the field of economic tree planting the same story is repeated and shows definite, important, and permanent results. It is true that in 1898 farmers throughout the Middle West, where tree planting finds its largest field of economic usefulness, were already alive to their need of planted timber. But the knowledge of what kinds of trees to plant and how to make them grow was imperfect. These were the fundamental problems: (1) The comparative adaptability of various species to regional and local conditions of climate, soil and moisture; (2) the comparative usefulness of the species which can be made to thrive; (3) the protective benefits of planted timber; and, (4) the rate of growth and the future yield which can be expected.

Substantial progress toward the solution of all of these problems has been accomplished. The Forest Service has made in all 300 separate planting plans for private owners, covering an aggregate area of over 50,000 acres, in 36 States and Territories. It has established in the minds of western farmers generally the fact that tree planting can be made successful and that it adds to the money value of their farms. It has also called attention to the great hygienic importance

of tree planting on the watersheds; of public water supplies of cities, east and west; has developed practical methods for reforesting denuded mountain slopes and for establishing new forest growth in regions of little rainfall, and has powerfully contributed to the great work of reclaiming desert lands through water conservation and to the whole irrigation movement.

The Gain in Economy of Use.

The Forest Service has in the last seven years added greatly to our visible forest resources. In the saving of waste it has enriched the country by many millions of dollars, and in this way alone has added vastly more to the National wealth than its total expenditures for all purposes during its entire history.

Its most important achievements in decreasing the drain upon our forests by providing for their more effective utilisation have been along four lines—determination of the strength of different kinds of timber, studies of methods by which timber may be made more durable, efforts to decrease waste in lumbering, and the discovery and introduction of better methods of gathering forest products other than lumber.

Reserve Administration by the Forest Service.

The Forest Service had become fully qualified, by its past work, for the responsibility laid upon it by the transfer of the reserves to its administrative charge. The immediate effect of the change was the opening of the reserves to much wider use than ever before. This is the natural consequence of intrusting the care of these great forests to the only branch of the Government which has the necessary technical knowledge. The inevitable consequence of a lack of such knowledge must be the restriction of right use or the practical certainty of misuse. Only under expert control can any property yield its best return to the owner, who in this case is the people of the United States.

The forest reserves are certain to become not only self-supporting but a source of large public revenue.

Private Lands.

The movement to introduce forest management on private lands is spreading rapidly, especially in the Pacific Coast States and the Middle West. Nearly four-fifths of the applicants for co-operative assistance were small owners. The total area for which assistance was asked was nearly 1,500,000 acres. Examinations to determine the practicability of management were made of 22 large timber tracts in 15 States, and detailed working plans were made for 8 large and 81 small tracts, with a total area of almost 2,000,000 acres.

During the year a revision of the terms of co-operative assistance was made to induce wider acceptance by small owners. Up to the present time 380 planting plans have been made, of which 49 were made during the past year."

So far Mr. Secretary Wilson.

The progress depicted in this Report is really quite marvellous. The people of the United States have recognised the immense importance of a systematic treatment of their forests, and the Government has provided the machinery for doing justice to the task. All this has been effected in the course of a few years. Why should not Canada, Australia and other parts of the Empire do likewise? Why should the Government of the United Kingdom, as pointed out on page 198, not give a helping hand by the establishment in this country of a central authority with a limited number of experts, who could go about and advise landed proprietors regarding the economic management of existing woods and the afforestation of lands which are either not wanted or not suited for agriculture? These experts could manage any woodlands which the State might acquire or establish on surplus lands, and they would have to attend to various other matters connected with the full development of forestry in this country.

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